SCIENTIFIC AMERICAN

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Vol. XCII.—No. 15.
ESTABLISHED 1845.

NEW YORK, APRIL 15, 1905.

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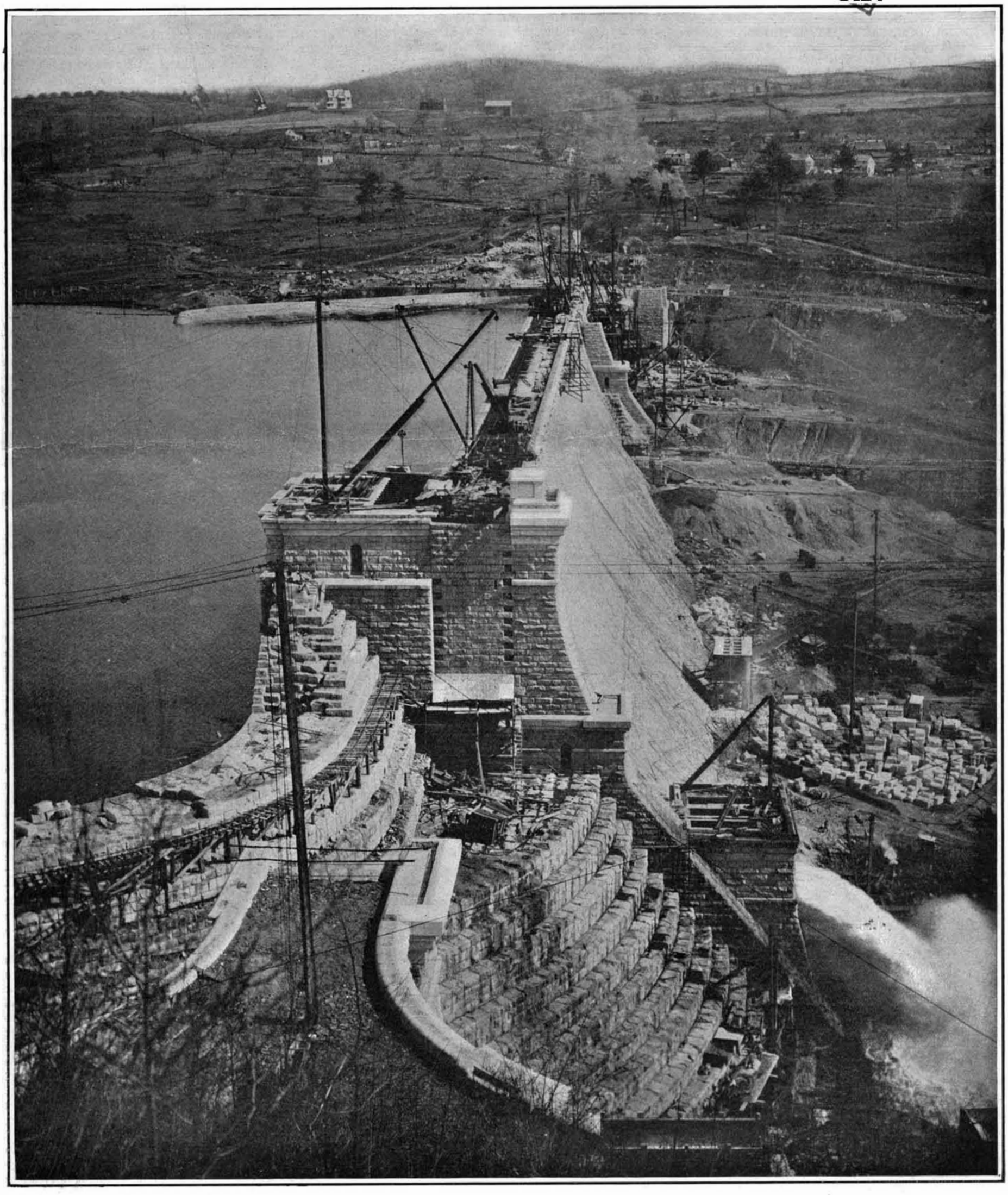

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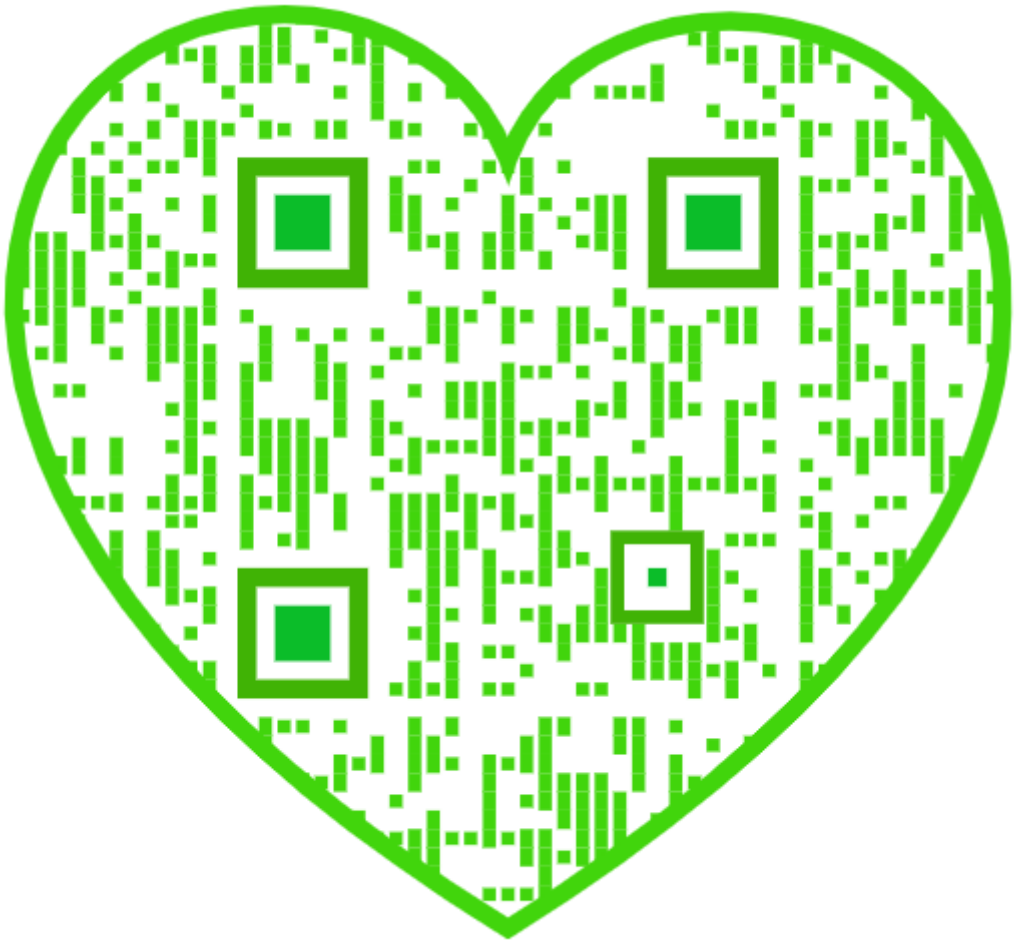
CLOSING OF THE CROTON DAM AND FILLING OF THE CROTON LAKE.—[See page 302.]



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ESTABLISHED 1845

MUNN & CO., - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

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MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, APRIL 15, 1905.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

VANDALISM AT NIAGARA FALLS.

That spirit of brutal utilitarianism which tries everything by the test of "the money there is in it," grows bolder with every success. We have scarcely cooled down from the bitter indignation that was aroused by the disfigurement of our new Subway by the bill-poster, before we are confronted with an attempt to sacrifice the beautiful American Falls of Niagara to the ambitions of a few men, who see visions of great profit in the energy of the falling waters.

We have made no protest against the previous use of Niagara Falls for commercial purposes, because it has not yet been attempted on a scale that would seriously interfere with the scenic beauties of the Falls; but the present attempt to secure legislative authority for developing something like half a million hydraulic horse-power, at the expense of the volume of water flowing over the American Falls, is so serious as to call for a halt in what is becoming a case of ugly vandalism. The New York State Geologist has stated that when 80,000 cubic feet of water per second has been taken away from the Niagara River above the Falls, the American Falls will cease to exist. The American Falls will run dry before the Canadian Falls, because the ledge over which they pass is at a higher elevation than the larger Falls on the Canadian side. The bills now before the Legislature, should they be passed, will give to the various companies that are behind them the power to take away an amount of water that will go far toward wiping out the greatest object of natural beauty east of the Rocky Mountains.

The Niagara Falls are the pride of America and the wonder of the world. They are a proper object of delight to millions of people, and they will naturally, unless they be destroyed, form, for all time to come, one of the most popular points of scenic interest in the world. On the other hand, "there is money" in these Falls—lots of it—for a few people. It is argued that there is much useful energy going to waste at the Falls, that could be turned to a great commercial advantage; but it is not necessary that this energy should be developed, inasmuch as equal energy can be developed in other ways, such as utilizing less important water falls, or by burning bituminous coal under steam boilers. But if this energy were produced from coal, it would be done with less profit to a few individuals than if it were developed at the Niagara Falls. In other words, there is more money in using up the Falls than in using up an equivalent amount of bituminous coal. Now, the object of the bills at Albany is to enable these few individuals to make that extra amount of money, represented by the difference in cost between generating a certain amount of energy from the Falls and generating the same amount of energy from anthracite coal.

That is exactly the long and short of it.

And the spirit which is back of this attempted vandalism is the same spirit that is becoming rampant throughout the whole of our commercial life—a spirit of cold, hard, ugly utilitarianism which, if not curbed in this and many other similar cases that confront us at every turn, will work irreparable injury to the ideals and the character of this, the youngest, and as many of us believe, the greatest among the nations of the earth.

THE TRUE POINT OF VIEW.

In the debate following a paper that was read at a recent meeting of the New York Railroad Club on the subject of heavy electric traction, there was the inevitable discussion of the relative economy of alternating current and direct-current traction. A new point of view was taken, however, when Mr. Wilgus stated that the question of adopting electric traction on steam roads was one rather of an increase in earnings than of a decrease in expenses. This, surely, is the lesson taught by the great success that attended the electrical equipment of the elevated roads in this city. It is true the change was accompanied by a decrease in expenses; but the economies secured in this way were insignificant compared with those that resulted from the great increase in passenger traffic, due to the larger trains, higher speed, and more frequent service, and the considerable increase in travel due to the greater comfort and cleanliness of electric traction. The success achieved on the elevated roads was due, not to the extension of the system, but to the development of the existing roads to the full measure of their carrying capacity. In the case of steam railroads, however, the increase in earnings should be, if anything, relatively larger than that on the elevated roads, for the quickening of the service, and the more frequent headway of trains, will enable the steam railroads to extend their suburban service to remoter districts, which at present, owing to the limitations of steam service, are too far removed to be reached by suburban travel. In the future, the question of the electrifying of steam railroads will not be determined by an academic discussion of the relative costs of operation of existing stretches of line, but it will be determined by a consideration of the increased earnings that would result from the wider distribution of population over a larger area of territory.

THE FASTEST 40-FOOT MOTOR BOAT.

It is well understood among designers of fast boats that we must have length for speed. Hence, in judging a high-speed performance, we must know the length of the craft that broke this or that record, before we can determine its merit. Quite a sensation has been created at the recent performance of "Napier II.," the motor boat that was constructed last year to represent Great Britain in the International Motor Boat contest. During the winter this vessel has been in the hands of her builders, Yarrow & Co., who have made considerable changes in the form of her hull, and have so far improved the boat that, during a recent trial, she covered the one-knot course used by the British Admiralty, in a strong wind and rough water, at a mean speed of 29.925 miles per hour. The changes in the model of the boat have consisted mainly in the sharpening of the entrance lines, while the twin engines have been lightened by taking metal out of the reciprocating and other moving parts. That a speed of just under 30 miles should be made by a boat only 40 feet long, is a really remarkable fact; and the "Napier II." must be reckoned as the fastest vessel of her length in the world.

In commenting on this performance, Mr. Yarrow stated that the high speed of the boat is largely due to the wonderful efficiency of the motors. If he were asked what speed he would be prepared to guarantee in a boat of the size of "Napier II.," if it were equipped with the type of boilers and engines which he places in the torpedo destroyers of which the firm turns out so many, he stated that he would not be prepared to guarantee more than 16 knots an hour. As showing the great increase of speed due to increase of length in these craft, Mr. Yarrow mentioned that a 60-foot torpedo boat with modern steam machinery is good for about 20 knots an hour, while a 200-foot boat with similar, but of course larger machinery, would make 30 knots an hour. Hence, it is inferred that since 26 knots an hour has been secured in the 40-foot "Napier" boat, 45 knots an hour could be secured in a 220-foot motor boat of the same general type.

COMPLETE THE PRESENT SUBWAY PLAN.

With a considerable show of reason, it is claimed by Mr. Belmont, of the Interborough Company, that his company should be given a fair chance to complete the original rapid transit system as laid out by the Rapid Transit Commission, of which the subways recently opened constitute but an incomplete portion. It will be remembered that the original plan contemplated, in addition to the roads that are now completed, an upper east side branch through Lexington Avenue and a lower west side branch from 42d Street to the Battery. These two branches were not included in the contract of the Interborough Company, for the reason that the city's debt limit was such as to place insufficient funds at the disposal of the Rapid Transit Commission for carrying out the whole scheme. It is claimed by Mr. Belmont that the first contract was undertaken in the full expectation that, when the city was prepared to build the two branches, thereby completing the system, his company would have the first option on doing this work. It is urged that when the Interborough Company put in a bid of only $2,000,000 for building the lower Broadway, East River tunnel, and Brooklyn extension, they bid $8,000,000 less than the actual cost of the work; and that they were willing to do this in order to maintain the Brooklyn and Manhattan system of lines intact in their own hands, with a view to being able to operate them under a single five-cent fare over the whole system.

Although there is no legal obligation binding the Rapid Transit Commission to allow the present company to complete the system as originally designed, it certainly does seem as though there was a certain measure of moral obligation. At the time that Mr. Belmont and those associated with him stepped into the breach and put up the vast sums of money necessary for the inception and carrying on of this great work, the Rapid Transit Commission was at its wits' end to know where to find a bidder. It should not be forgotten that the Metropolitan Street Railway Company, which, as newly incorporated, and under a new name, is now burning with zeal to build subways, would have nothing whatever to do with rapid transit four or five years ago. It is only when the present Subway Company has proved that subways are a valuable property, that the Metropolitan interests become anxious to take up the very work at which they looked askance only a few years ago. Both the company and the city are the gainers by this change of heart; for it is probable that the Metropolitan interests will figure largely in the building of future subways. Nevertheless, it would seem desirable that, for the reasons stated above, the original subway should be completed and operated by one and the same concern, provided, of course, that their bid is put in at the prevailing prices for such work.

THE CHEMISTRY OF PAINTING AND THE PRESERVATION OF CANVASES.

BY GEHEIMER HOFRAT PROF. DR. W. OSTWALD, OF LEIPZIG.

Little improvement has been made in the technique of oil painting since Pettenkofer, forty years ago, explained its scientific principles and exposed the antiquated character of current knowledge and practice. The temperature and humidity of picture galleries is now regulated in accordance with Pettenkofer's recommendations, and his method of renovating paintings has been adopted and developed, but the important question, how to produce durable paintings, is still neglected, even by the best technicians, as is shown by the proportion of obviously short-lived works in every collection. What is still more remarkable, picture buyers, both governmental and private, pay no attention to the expectation of life of their dearly-bought treasures. I know a very costly Makart which, though little more than twenty years old, is already a senile wreck. Its brilliant colors have become muddy, all detail is gone from the shadows, and the whole picture is flaked, cracked, and wrinkled. A celebrated Knaus in the Leipzig Museum has become so covered with cracks that it has been taken down, and some of Menzel's early works are in little better condition.

So our art treasures are perishing before our eyes. Has the same condition always existed, and must it continue to exist? Neither the one nor the other. When we look at the splendid Van Eycks in the Berlin Museum, which have retained their brilliant hues almost unchanged for nearly five centuries, we infer that the swift decay of modern works is not an organic necessity. It may be objected that the method by which these durable old paintings were produced is irretrievably lost. True; but it is surely as possible to make permanent pictures now as it was then.

The first requisite is a certain amount of scientific research; the second and more important is that artists and purchasers should pay the same conscientious regard to permanence that was paid in Albrecht Dürer's time.

We require of the architect, as a matter of course, that his artistic creations shall not crumble in a few years; but the genius of the painter, it is assumed, must not be fettered by chemical laws or petty technical considerations. Yet so great an artist as Boecklin devoted his life to technical experiments, and he might have carried them further and given freer scope to his genius if he had also known a little chemistry. For example, he used pure vermilion with startling and unpleasant effect, because he fancied that vermilion is permanent when used alone but is affected by other pigments. The truth is that some varieties of vermilion withstand the action of light very well, while others turn gray or brown, whether used alone or with other colors. If one speaks to a painter of these things, he retorts that chemistry is the root of the whole evil; the Van Eycks knew nothing of it, and made durable pictures, but the modern aniline colors fade. This is unjust, for nineteenth-century artists painted fugitive pictures before aniline colors came into use. The fault is not in the colors, but in the medium. Now, as formerly, the palette of the oil painter consists chiefly of pigments of unquestioned permanence. All the yellow and red ochers, most blacks and browns, ultramarine, cadmium yellow, chrome green, and some other colors remain unchanged for thousands of years; indigo, madder, and Prussian blue endure for centuries. The former are the pigments of thirteenth-century and fourteenth-century frescoes; the latter are found well preserved in still older miniatures.

But these are not oil paintings. The medium is carbonate of lime in the frescoes, gelatine or albumen

in the miniatures. Nor are the Van Eycks above mentioned oil paintings in the modern sense. The method employed in their production is not recorded, but it could be ascertained by micro-chemical examination. Many technical questions might be solved by such examination of minute fragments, which could be taken from the edges of pictures without material injury.

Still, some genuine oil paintings are very permanent; for example, Raphael's "Sistine Madonna" in the Dresden gallery. Now, a comparative study of old oil paintings shows that those which are best preserved are *very thinly painted.* This is not a mere coincidence. The evils of oil increase with the thickness of the layer of paint, and are further intensified by applying one color over another. Hence the works of Rubens, painted thinly and rapidly, are so much better preserved than Rembrandt's; and, for the same reason, Knaus's pictures, painted apparently on an asphaltum ground, have decayed so soon. In short, though it is possible to make permanent oil paintings, conditions fatal to permanence are very apt to occur. One such condition is the use of thick masses of color, or impasting.

In spite of these obvious disavantages, oil has practically displaced all other media, because it permits the artist to judge the effect of his work at once, as oil colors do not change appreciably in drying. Water colors alter perceptibly, and *gouache* still more, and the painter must make allowance for the alteration. But though the oil painting does not change in drying, or in weeks or months, it changes inevitably in decades and centuries, and always in the same way, by assuming a general yellowish brown cast, called the "gallery tone."

Is there no remedy? I know none for the yellowing of oil with age, but we may take a broader view, and seek a method which shall retain the chief advantage of oil painting and yet avoid its defects. Such a method is pastel.

Pastels show no trace of "gallery tone," but remain bright and fresh for centuries. They are executed with dry colored crayons, which adhere loosely to the ground, and must therefore be protected with glass. Pastel allows the greatest freedom of treatment, and unsatisfactory parts can be wiped off and done over as often as necessary. When I recommend this method to painters, they say: "Very true! If one could only *fix* the pastel." Even this is possible. In my "Notes on Painting" I have given the formula of a fixative which enables a pastel picture to be rolled, dusted, and cleaned with bread crumbs without injury. This brings us back to a medium, but one which is used in very small quantity and does not darken with age, but at the worst only disappears, when it may be reapplied. When I add that pastel is suitable for pictures of every size and character, that it is the cheapest of all methods, and that it enables the artist once more to prepare his own colors and assure himself of their purity, it will be understood why I regard it as the method of the future.

[NOTE.—Malerbriefe. Beiträge zur Theorie und Praxis der Malerei. Von W. Ostwald. Leipzig, Hirzel, 1904. 165 S. In this book the eminent chemist, who is also an artist of talent, ascribes the permanence of the Van Eyck pictures in part to the fact that they are on wood, strongly recommends the use of wood, cardboard, or metal instead of porous canvas, and also advises that oil paintings be protected from the air by glass.—ED.]—Condensed from Die Woche.

NIAGARA POWER AT GOAT ISLAND.

BY ALTON D. ADAMS.

If Niagara Falls is abolished, Goat Island will become the greatest power site in the world. Canada and New York State have already made a long start toward destruction of the American Falls, and, as soon as this result is accomplished, Goat Island will be available for power purposes.

Money is the motive that is leading Canada to dry up the American Falls, but New York is granting away great water rights without compensation.

Under natural conditions, power development on the New York side of the Niagara River can be more easily and cheaply carried out than it can on the Canadian side, but this advantage is offset by the exclusion of power plants from the New York State Reservation, and by the high value of real estate in the city of Niagara Falls. As soon as the American Fall disappears, the policy of New York in excluding power plants from Goat Island can no doubt be reversed. The tendency toward this result will be increased by the knowledge that Canada is deriving a large revenue from the water which its power plants suck up. With Goat Island open for power development, the balance of advantage in the cheap production of energy will turn strongly to the American side of Niagara River.

The precarious situation of the American Falls, in view of the present and prospective diversion of Niagara water, and the great superiority of Goat Island as a power site, are both evident on inspection of a map of the river above and below the Falls. Just upstream from Goat Island the Niagara River is 4,200 feet wide, but that part of the water which goes to the American Falls shrinks to a width of only 400 feet near the upper end of the island. Even this narrow bed does not carry a deep unbroken current, but the uneven bottom breaks the shallow water into scores of minor cascades. It is estimated that as little as 10 per cent of the total discharge of the river goes down the channel to the American Fall; and within the memory of men a strong east wind has so lowered the river, by piling up the water at the west end of Lake Erie, as to leave the brink of this cataract bare. When canals, pipe lines, and tunnels suck down a large part of the discharge of the river, the narrow line of cascades above the American Falls will be laid bare, while the far wider and deeper channel between Goat Island and the Canadian bank will be comparatively unaffected. Thus will the American Fall disappear. With the passing of this cataract, Goat Island and the adjoining part of the Reservation on the New York bank will become united by the dry bed, and present a most favorable site for power development. From that corner of the New York Reservation which is close to the new suspension bridge over the Niagara River to the junction of Goat Island with the Horseshoe Fall, there is a shore line 3,200 feet long at the base of the perpendicular cliffs. With the channel to the American Fall dried up, the shore line on the upper river from the lower end of Goat Island to a point opposite its upstream end, on the New York bank, would measure nearly 4,000 feet. Between these upper and lower water fronts, that differ in elevation by 160 to 200 feet, only a narrow peninsula of rock would intervene. Over, through, and beneath this peninsula enough canals, pipe lines, and tunnels might be constructed, at a minimum of expense, to swallow any desired part of the Niagara waters. The deepest part of the channel between Goat Island and the New York bank might, with some excavation, be made to carry a large volume of water for power houses located either at the crest or the foot of the present American Fall. Near the lower end of Goat Island, close to the Horseshoe Fall, either canals, pipes, or tunnels, each several hundred feet long, would suffice to convey the water at trifling cost to wheels at the level of the lower river. With such possibilities for the development of cheap and practically unlimited power, it is little wonder that promoters are looking with longing eyes at Goat Island.

But it may be questioned whether New York or Ontario will ever allow enough water to be diverted from the Niagara River to dry up the channel that leads to the American Fall. Just here comes in the influence of competition in grants of water rights by the two governments; and it should be held in mind that while New York has full power to make such grants, it has no power, as one of the American States, to enter into any treaty with Canada for the limitation of such rights. At the rate charters have been granted to divert water from the Niagara River during the past decade, less than another ten years would see New York corporations with power to divert enough water to dry up the American Falls. But suppose that New York, to save its falls, discontinues the granting of water rights. Canada will still be free to lease power sites, and the Horseshoe Falls will still present a grand spectacle when the site of the American Fall is as dry as the sands of Sahara. Is it probable that Canada, out of pure kindness to New York, and merely to save the American Fall, will forego the larger revenue it may derive from the sale of further water rights? Ontario already receives a minimum yearly rental of $60,000 from the three great power companies whose works are under construction in Queen Victoria Niagara Falls Park. When these works are in full operation, an additional revenue of nearly $250,000 per year will be received by the government as a royalty on every horse-power developed. This great revenue, amounting in all to more than $300,000 annually, is to be received as compensation for the right to divert about 32,000 cubic feet of water per second from the Niagara River just above the Horseshoe Falls, or more than twice the volume that is diverted on the New York side. Large as is the sum just named, Ontario wants more, for its government has purchased or acquired the entire river front of the Canadian frontier between Lake Erie and Lake Ontario, a distance of more than thirty miles, and large amounts must be obtained to meet the interest on the purchase price of these lands, pay off the principal, and develop them. With an eye to all this, the Ontario government is considering the sale of further power privileges at the Falls, and has obtained a report from a hydraulic engineer to the effect that at least another 30,000 cubic feet of water per second can be conveniently diverted from the upper river. This would raise the total volume of water to be diverted on the Canadian side of Niagara River just above the Falls to about 62,000 cubic feet per second. For purposes of navigation, and for the several power plants that it feeds, the Welland Canal draws an unknown quantity of water from Lake Erie, but it is known that a single one of these power plants, the largest, has wheels with a capacity of 1,400 cubic feet of water per second. It is perhaps not an overestimate to say that the Welland Canal draws as much as 3,000 cubic feet of water per second from Lake Erie; and this with the above figures would raise the total proposed draft from the lake, in Canada, to 65,000 cubic feet of water per second. On the New York side of Niagara River, the power plants about the Falls, or under construction there, have an authorized capacity of about 32,000 cubic feet of water per second, and to this should be added the 1,200 cubic feet estimated for the New York barge canal between Buffalo and Savannah, and not less than 6,000 cubic feet per second for the Chicago drainage canal. These figures for the actual and proposed diversion of water from the Great Lakes and Niagara River, in the United States, form a total of fully 39,000 cubic feet per second. Adding this last-named quantity to the volume of water that may be diverted on the Canadian side at no distant day, brings the total volume that is to be sucked away from the lakes and river above the Falls up to 104,000 cubic feet per second. In 1899, the United States engineers found that while the discharge of Niagara River is 222,000 cubic feet per second for mean Lake Erie level, this discharge sinks at times to as little as 165,340 cubic feet per second. The proposed diversion of almost one-half of the normal discharge of Niagara River would probably dry up the American Fall, save at times of high water, and this result must certainly follow when the water is low. With the Fall reduced to an intermittent spectacle, there can be little further motive to exclude power plants from Goat Island.

SCIENCE NOTES.

Particulars of a new and painless anæsthetic are published by the Petit Journal. This drug, which is obtained from a plant found in Japan, has been named "scopolamine." It is administered by hypodermic injection, and has the effect of inducing deep sleep for eight or nine hours. Scopolamine, it is claimed, is far superior as an anæsthetic to any of the drugs at present in use for the purpose of operation, and has absolutely no after effects.

Explaining the four types of radio-active substances at the Royal Institution, Prof. J. J. Thomson showed how the beta substance attracted and repelled an object much in the style of a pendulum. Unless the object were removed, he said, it would be made to swing so long as the radium lasted—say, a million years—so that with some clockwork attached to the pendulum we should have a clock that would require winding up only once in a million years.

Dr. Karl Pearson, of University College, London, states that a man of mediocre ability can observe and collect facts, but that it takes the exceptional man of great logical power and control of method to draw legitimate conclusions from them. He thinks that at least fifty per cent of the observations made and the data collected are worthless, and that no man, however able, could deduce any result at all from them; that, in the language of engineers, we need to "scrap" about fifty per cent of the products of nineteenth-century science; that the scientific journals teem with papers that are of no real value at all, recording observations that cannot be of service to any one, because they have not been undertaken with a due regard to the safeguards which a man takes who makes observations with a view of testing a theory of his own; that in other cases the collector or observer is hopelessly ignorant of the conditions under which alone accurate work can be done; that such a man piles up observations and data because he sees other men doing it, and because that is supposed to be scientific research. Prof. Pearson feels that sociological observations are of the lowest grade of value in too many cases; that even where the observers have begun to realize that exact science is creeping into the sociological field, they have not understood that a thorough training in the new methods is an essential preliminary for effective work, even for the collection of material; that these observers have rushed to measure or count any living form they could hit on without having planned *ab initio* the conceptions and ideas that their observations were intended to illustrate. Dr. Pearson is skeptical about the right men or the right man, and he thinks the securing of these men is the chief difficulty in organizing any force for the scientific interpretation of the great mass of data now existing; but he says that when the right man is found he must have been rightly trained; that he is to be occupied in drawing logical conclusions from other persons' observation and data; that therefore he must, in the first place, be an adept in scientific method, a first-class mathematician and statistician, and a trained calculator and computator. Such a man will be the man who has the courage to "scrap," and do it relentlessly. Science wants immensely the courageous pruner, but Dr. Pearson feels that such a task is not an enviable one.

STANDARD TIME AT A MODERN WATCH WORKS.

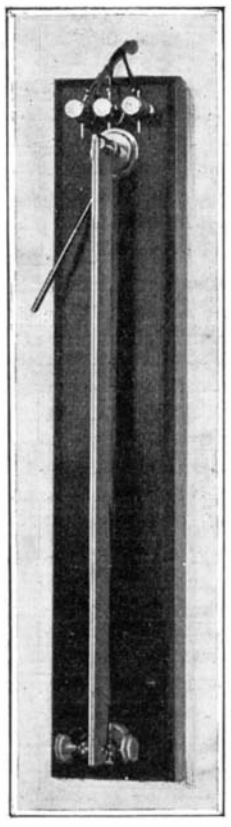
AMONG the many fields of industry in which hand labor has been superseded by automatic machinery, there is none in which the change has been so strikingly complete and successful as in that of the manufacture of watches. That the machine-made American watch of the higher grades can attain as high marks for time-keeping as the finest products of the skilled watchmakers of some of the older countries of Europe has been proved by tests at the National Laboratory, London. This fact is the more remarkable when we remember that the Waltham Works, from which the test watches referred to were selected, is turning out watches at the rate of nearly three thousand per day.

It is not our intention to describe, just now, the wonderfully complex and ingenious machinery by which the American watch is made; that is a long and deeply interesting story in itself. The present article will show how one great, modern watch works maintains its own private standard of time, for the guidance of the workmen in the various rooms of its vast establishment, in regulating the watches that are turned out at the rate of so many thousand a day.

The possession of some Standard of Time must be reckoned as one of the absolute necessities of the highly-developed life of to-day. Every man's watch is his own particular standard. In case of doubt as to its accuracy he refers to some other higher standard, such, for instance, as a public clock or the chronometer in some watchmaker's window. In case these higher standards should disagree, it is necessary to go to some ultimate standard, superior to all of them. The ultimate standard in the United States is the time determined at the Naval Observatory, Washington; and this is referred to the transit of fixed stars across the meridian, which is a time which never varies, and therefore is the absolute standard.

Many years ago the Waltham Watch Company realized that it would be to their interest to get as closely in touch as possible with the prime source of time, which, for them, would be the transit of any celestial body, preferably a fixed star, across their meridian; and acting under the advice of the late Prof. Rogers (at that time connected with Harvard Observatory, Cambridge), they built in the works an observatory, and put in a transit of the size and form that is standard in the Geodetic and Hydrographic Surveys. In connection with the observatory they also constructed a clockroom, in which they placed two master clocks, which were designed specially for the purpose by the superintendent of the works. As far back as the forties the longitude of Harvard Observatory from Greenwich had been established by taking the mean time of forty box chronometers. At a later date this longitude was verified by means of cable connections between a chronograph at Greenwich and a chronograph at Harvard University, connected by the transatlantic cable. In 1880 the longitude of the Waltham Observatory from Harvard was similarly established, by means of two electrically-connected chronographs.

As the plant of the company increased in size, the vibration of the heavier moving machinery, that was transmitted through the clockroom, the earth to ceptible variation caused operations in the time of the two master clocks. It was decided, therefore, to build the new clockroom, of which we present several illustrations, in stall within it the two master clocks, and add a sidereal clock. The room was completed early in 1904 and is now running, as we shall show later in this article, with excellent results as to accuracy.



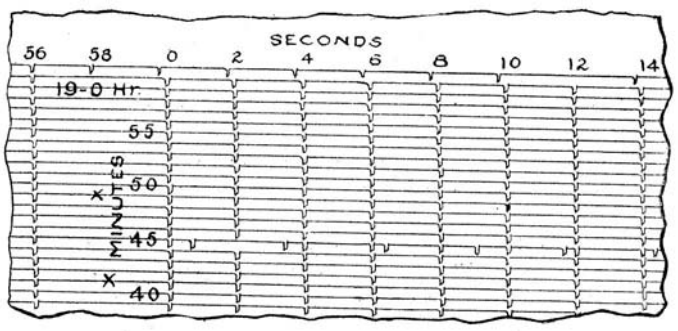
Thermostat for Regulating Temperature of Clockroom.

The clockroom, which is located in the basement of the buildings, is one of the double shell of brick. The built with a hollow tile rests upon the outer shell basement, and floor of the within two or its ceiling is the basement three inches of inner shell is ceiling. The and 8 feet in 10 feet square ured from the height, meascellar floor. level of the 18-inch space There is an walls of the between the er shell and a inner and out- between the 9-inch space On the front two ceilings. ing the walls of the buildapart to are 3 feet various scientific instruments, such as the chronograph, barometer, thermostat, level-tester, etc. The inner house is carried down 4 feet below the floor of the basement, and rests upon a foundation of gravel. The walls of the inner house below the floor level consist of two thicknesses of brick with an air space between, and the whole of the excavated portion is lined, sides and bottom, with sheet lead, carefully soldered to render it watertight. At the bottom of the excavation is a layer of 12 inches of sand, and upon this are built up three solid brick piers, measuring 3 feet 6 inches square in plan by 3 feet in height, which form the foundation for the three pyramidal piers that carry the three clocks. The interior walls and ceilings and the piers for the clocks are finished in white glazed tiling. The object of the lead lining, of course, is to thoroughly exclude moisture, while the bed of sand serves to absorb all waves of vibration that are communicated through the ground from the various moving machinery throughout the works. At the level of the basement floor a light grating provides a platform for the use of the clock attendants.

Although the placing of the clockroom in the cellar and the provision of a complete air space around the inner room would, in itself, afford excellent insulation against external changes of temperature, the inner room is further safeguarded by placing in the outer 18-inch space between the two walls a lamp which is electrically connected to, and controlled by, the thermostat, of which we give an illustration. The thermostat consists of a composite strip of rubber and metal, which is held by a clamp at its upper end and curves to right or left under temperature changes, opening or closing, by contact points at the lower end of the thermostat, the electrical circuit which regulates the flame of the lamp. The thermostat is set so as to maintain the space between the two shells at a temperature which shall insure a constant temperature of 71 deg. in the inner clock house. This it does with such success that there is less than half a degree of daily variation.

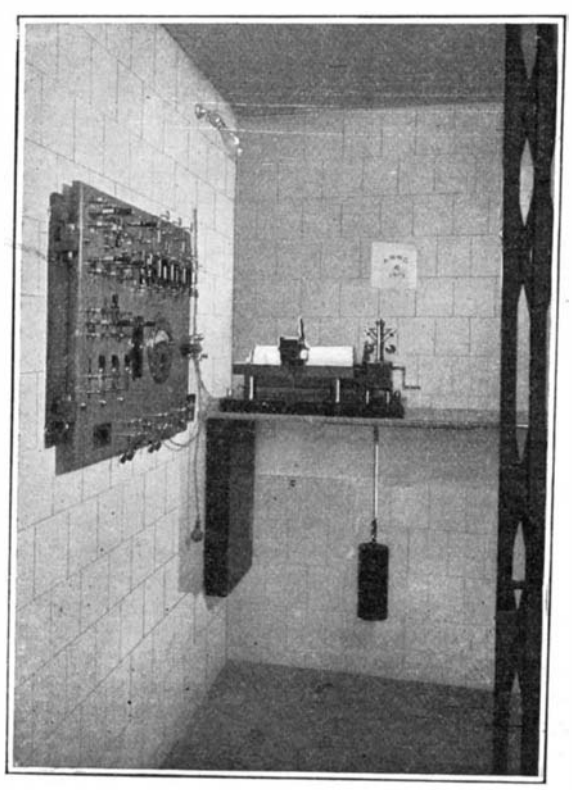
The two clocks that stand side by side in the clockroom serve to keep civil time, that is to say, the local time at the works. The clock to the right carries a twelve-hour dial and is known as the mean-time clock. By means of electrical connections it sends time signals throughout the whole works, so that each operative at his bench may time his watch to seconds. The other clock, known as the astronomical clock, carries a twenty-four-hour dial, and may be connected to the works, if desired. These two clocks serve as a check one upon the other. They were made at the works and they have run in periods of over two months with a variation of less than 0.3 of a second, or 1-259,000 part of a day. The third clock, which stands to the rear of the other two, is the sidereal clock. It is used in connection with the observatory work, and serves to keep sidereal or star time.

Sidereal time is determined by the transit of the fixed stars across the meridian. The stars are at such enormous distances from the earth that their transit is not appreciably affected by the revolution of the earth in its orbit. It is the change of position of the earth with regard to the sun that accounts for the daily difference between sidereal and solar time of 3 minutes 56.55 seconds, the solar day being shorter than the sidereal day by this amount. The passage of a particular star across the meridian at Waltham is noted in the works' observatory on two nights of every week, and an exact record of this time is obtained by



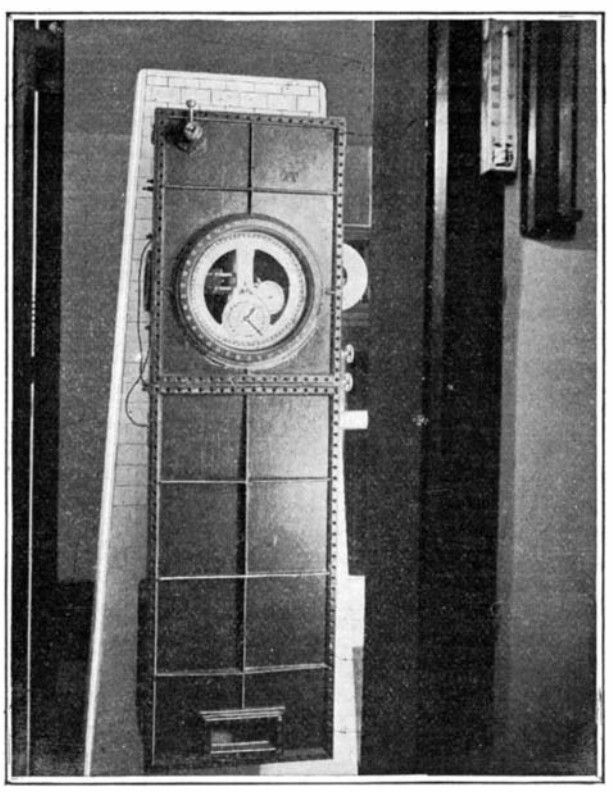
The parallel lines are traced on a rotating drum by a pen which is electrically connected with the sidereal clock. At every alternate second, a jog is made in the line. The intervening jogs record the time of passage of a fixed star across the field of the transit.

Portion of a Chronographic Record.



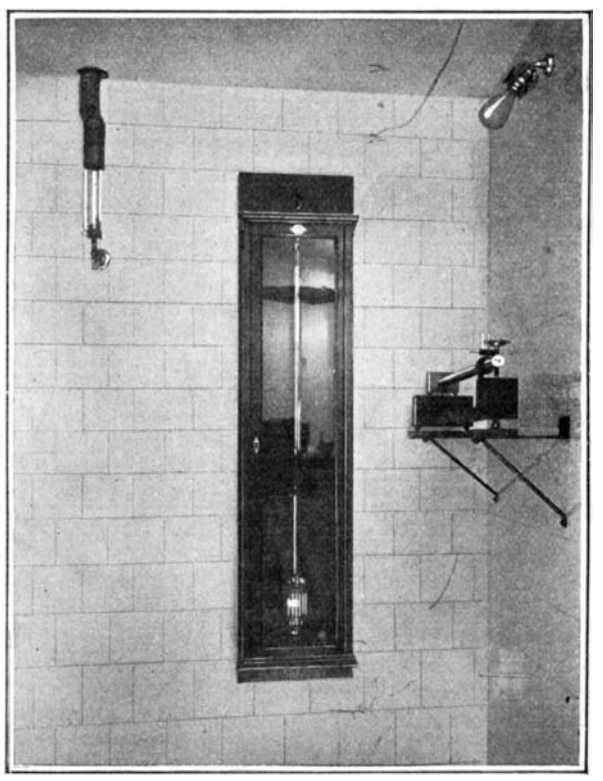
On shelf on rear wall is the chronograph. To the left is the switchboard, for controlling the lights and the electrical connections from the clocks to the various workrooms.

View in Outer Passage of Clockroom.



This clock is protected from barometrical changes by being inclosed in an airtight case to which an air pump is attached.

Astronomical Clock in Inner Building, as Seen from Outer Passage.



The barometer, and, on shelf at right, the level-tester for correcting transit levels.

Another View in Outer Passage.

HOW STANDARD TIME IS MAINTAINED AT A MODERN WATCH WORKS.

means of a chronograph. The chronograph, which is carried on a shelf in the space between the inner and outer shells of the clockroom, consists of a horizontal metal drum, rotated at such a rate of speed by means of a weight as to give exactly one revolution per minute. Upon the drum is fastened a sheet of paper. In front of the drum is a small carriage, which is moved laterally, by means of a revolving feed screw. This carriage carries a pen that normally traces a continuous straight line on the sheet. The pen is electrically-connected to the sidereal clock, and at every full oscillation of the pendulum, or at every alternate second, the electrical circuit is broken and the pen makes a slight jog in the line. The speed of the cylinder is so arranged that the distance between the jogs corresponds to a certain scale, say of one inch to the second. The pen carriage of the chronograph is also electrically-connected to the observatory, where a button is placed conveniently to the hand of the observer. When an observation of a transit is to be made, the chronograph is started and the observer, with his eye at the telescope, presses the button at the instant that the star passes each vertical hair line (there are five in all) in the eye-piece of the transit. Each time the button is pressed, an extra jog is made on the paper; and by using a scale graduated, say, to 0.01 inch, it is possible to determine to one-hundredths of a second the time of the transit of the star across each hair line. By taking the mean of these five observations, it will be seen that the time of the transit of the star is obtained with remarkable accuracy. The next step is to compare the time of transit as recorded by the sidereal clock at Waltham with the time of transit of the same star as given in the tables of the "Ephemeris."

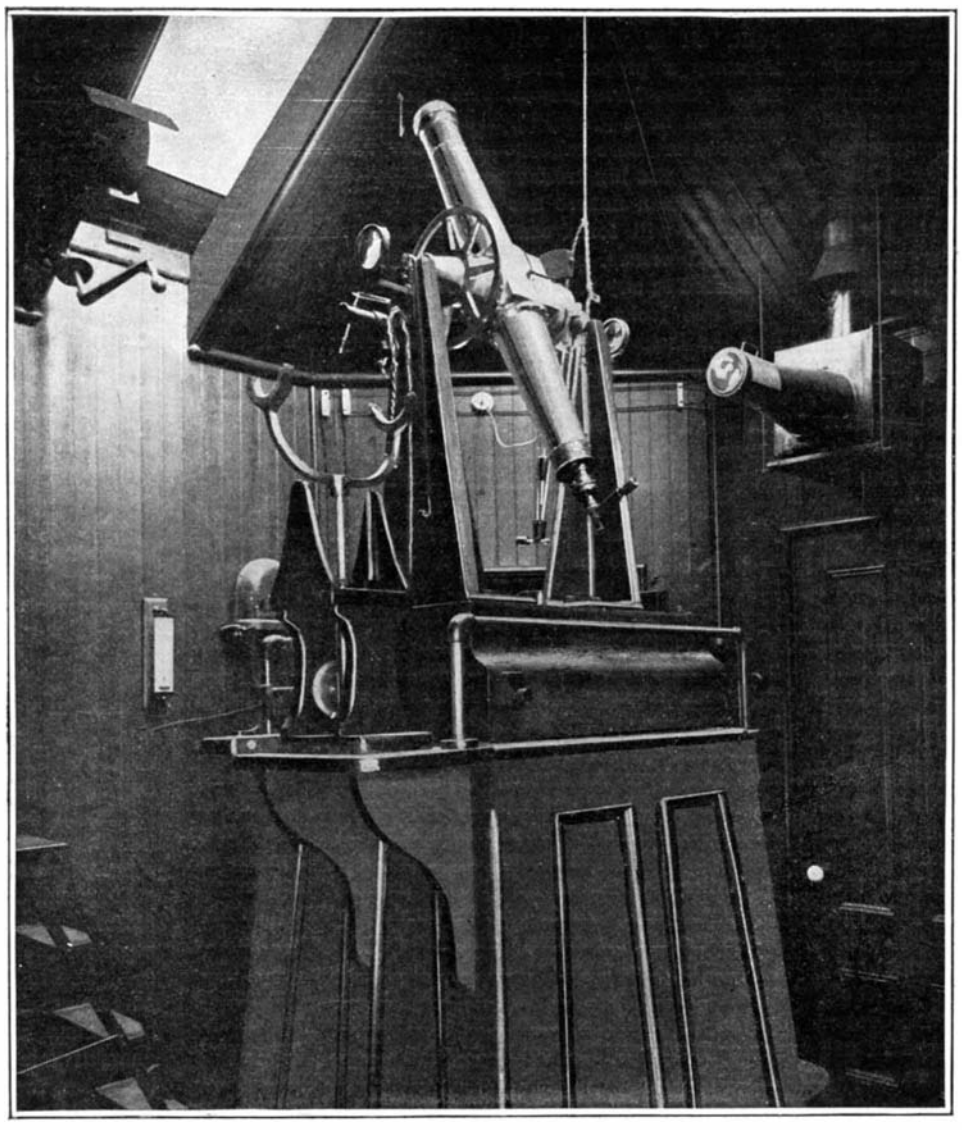
The "Ephemeris" is an official publication, issued annually, which gives the exact position of the heavenly bodies for every day of the year; and from this the exact time of the transit of the particular star observed may be known. Whatever the sidereal clock differs from this time is the error of the clock. The amount of this error is then compared with the amount of error observed at the last observation, and the difference between the two observations, divided by the number of days, gives the daily rate of variation. This rate, as observed at the Waltham works, rarely exceeds one-tenth of a second per day. That is to say, the sidereal clock will vary only one second in ten days, or three seconds in a month. The variation, as found, is corrected by adding or subtracting weights to or from the pendulum, the weights used being small disks, generally of aluminium.

Summing up, then, we find that the great accuracy obtained in this clockroom is due to the careful elimination of the various elements that would exercise a disturbing influence. Changes of temperature are reduced to a minimum by insulation of the clockhouse within an air space, in which the temperature is automatically maintained at an even rate. Changes of humidity are controlled by the specially designed walls, by the lead sheathing of the foundation pit, by the preservation of an even temperature, and by placing boxes of hydroscopic material within the inner chamber. Errors due to vibration are eliminated by placing the clocks on massive masonry piers which stand upon a bed of sand as a shock-absorbing medium.

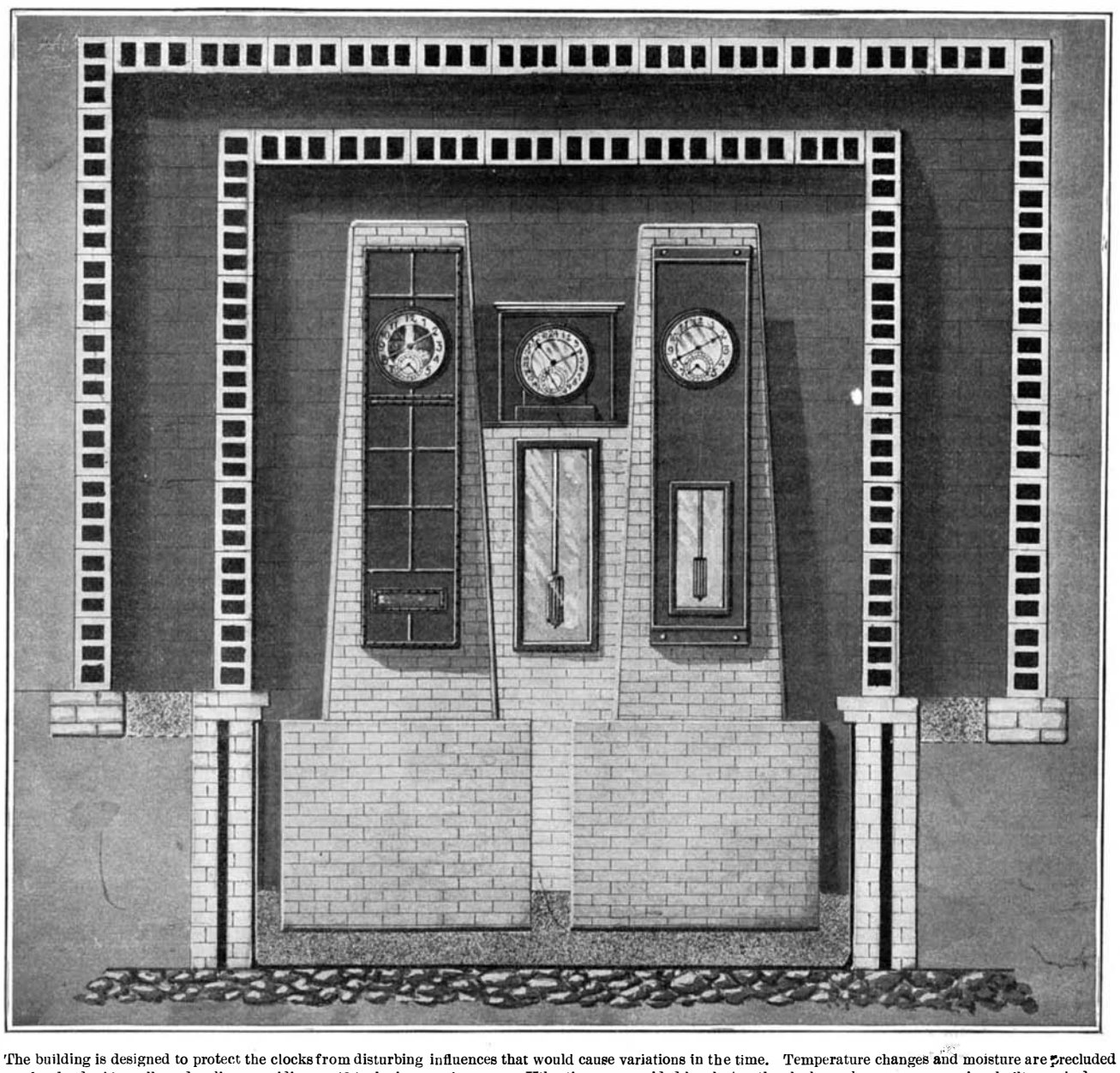
The astronomical clock is inclosed in a barometric case, fitted with an air pump, by which the air may be exhausted and the pendulum and other moving parts relieved from barometric disturbances. For it must be understood that variation in barometric pressure means a variation in the density of the air, and that the speed of the pendulum must necessarily be affected by such changes of density.

This equipment is the only one in the world forming part of the equipment of a watch factory, and is believed to be the equal of anything of the kind yet installed.

In conclusion, it may be mentioned that of late years it has been the custom of the company to submit a percentage of its watches to the National Physical Laboratory at the Kew Observatory, London, an institution which accepts instruments of precision from applicants all over the world, tests them, and makes a report. Eighty-six per cent of the watches submitted by the Waltham Watch Company have been accepted and passed in Class A. A mark for accuracy of as high as 80 to 85 per cent is a common figure. This result is extremely interesting as showing that American automatic machinery has been brought to such a pitch of perfection that the machine-made watch is able to hold its own at this laboratory with the finest products of European hand labor.



Interior of the Observatory, Showing the Transit.



The building is designed to protect the clocks from disturbing influences that would cause variations in the time. Temperature changes and moisture are precluded by the double walls and ceiling providing an 18-inch air space between. Vibrations are avoided by placing the clocks on heavy masonry piers built on a bed of sand. The pair of clocks in the front are the master clocks, which, by electrical connections, give the time throughout the works. The sidereal clock to the rear which is checked, twice each week, by observing the transit of the stars, serves as the standard for the whole works.

Sectional View Through the Clockroom.

HOW STANDARD TIME IS MAINTAINED AT A MODERN WATCH WORKS.

A Chicago machine and Chicago operators won all the prizes at the speed and accuracy contest open to all comers at the Coliseum on March 20. There were $165 in prizes offered in three classes—adding department store checks, adding columns, and multiplying. Owing to lack of time, prizes in the first two classes only were contested for. An operator at Marshall Field & Company's retail store added correctly five hundred department store checks in four minutes and fifty-five seconds, receiving first prize for speed and accuracy in adding department store checks. An operator at the Illinois Central Railroad Company freight auditor's office added correctly six columns of numbers, each equal to a ledger page, in four minutes and thirty-nine seconds. An employe of the C., B. & Q. Railroad car accountant's office won the second prize in the same class in four minutes and forty-one seconds.

THE OPENING OF THE NEW CROTON RESERVOIR.

To be paradoxically correct, one would have to say that the recent opening of the new Croton reservoir was accomplished by closing it, that is by shutting down the gates through which the Croton River had been flowing through the dam during construction. In building the vast wall of masonry, 297 feet from foundation to crest at its deepest part, it was necessary to make provision for the escape of the Croton River, until the time should come for filling the dam. This was accomplished by blasting out a temporary channel along the north side of the valley, and leaving a tunnel through the dam in which was laid a pair of 4-foot iron pipes provided with gates. As the time approached for filling the dam, the tunnel was blocked up with masonry, leaving these two 4-foot pipes for the river to run through. They were laid at an elevation of 140 feet above the lowest point of the foundation, and about 150 feet below the high-water mark of the reservoir. At an elevation of about 50 feet above these pipes, that is to say above the bed of the river, three 4-foot blow-off pipes, provided with gates, were built into the dam wall, the object of these pipes being to provide an outlet, if at any time it should be necessary to keep down the height of the water, say in time of flood, or to draw down the water for other purposes, incidental to the operation and maintenance of the reservoir.

In view of the fact that the daily consumption of water by New York city is about 300,000,000 gallons, and that in some years the average daily flow of the Croton River is only about 400,000,000 gallons, the prediction was freely made, during construction, that the excess of supply over demand was so small, that it would be many years before the Croton Dam would be filled to its high-water level, at which it would hold some thirty billion gallons of water. Little did these prophets understand the ways and moods of the Croton watershed, which, by the way, covers an area of 360 square miles. During the past winter there was a record snowfall of about 50 inches over the whole of this area, and because of the long-sustained period of low temperature, but very little, if any, of this had melted and run off. Consequently, when the sudden and considerable rise of temperature and the heavy rainstorms of the middle of March occurred, this great storage of moisture was unsealed, and there was an abnormal run-off into the Croton Valley. So great was this, that in a single day of the thaw there was an inflow of 1,500,000,000 gallons of water. Had the remaining 30 feet of height of the dam been completed, it is probable that this spring would have seen the Croton Reservoir standing at its high-level mark.

The gates of the two 4-foot blow-off pipes in the bed of the river were closed on January 28, and the exit being cut off, the water began to accumulate back of the great wall. Because of the freezing weather, the water at first rose very slowly, the rise being about 28 feet from January 28 to March 11. Then commenced the rapid thaw and heavy rains, and the dam began to fill very quickly. During the twenty-four hours of March 20-21, the water rose 7.22 feet, or from elevation 121 to about elevation 128. As the lowest gap in the spillway was at elevation 171, or thirty feet below the finished crest, it was determined on March 21 to open the three 4-foot gates that control the blow-off pipes; and in spite of the fact that several hundred million gallons of water per day passed out through these gates, so rapid was the thaw that, from March 22 to March 25, the water still continued to rise at the rate of 3 feet per day. Moreover, from March 25 to March 27 it rose 14.48 feet, which is equal to a flow of 1,500,000,000 gallons per day. Although the water rose to within a foot of the lowest gap in the spillway, there was no time at which any water passed over the spillway; nor was there at any time the slightest cause for the alarmist rumors which found their way into the daily press concerning the insecurity of the dam.

At the time of our visit to the dam, when the accompanying pictures were taken, the water stood at elevation 168, or about 70 feet above the 4-foot blow-off pipes. All three pipes were fully open, and under this head there was an escape of water estimated at 1,000,000,000 gallons per day. The resulting effect was a veritable little Niagara, which with its dull reverberation and its ever-changing clouds of vapor, floating picturesquely above it, brought forcibly to mind a visit once paid to the Cave of the Winds at Niagara.

The work remaining to be done on the dam proper and the spillway consists in carrying up some 400 feet of the southerly portion of the dam, through a height of about 35 feet, to its full height and the completing of some gaps in the spillway. A graceful steel arch bridge will be built across the spillway, connecting the driveway over the crest of the dam with the road that is being built along the rocky bluffs that form the northerly shore line of the reservoir. Meanwhile, the derricks, storehouses, engines, railway tracks, and other evidences of the contractors' work will be cleared away from the space below the dam, and the surface will be graded into graceful slopes and sodded. Graveled walks will be laid out and a large fountain built, all of which will give the vast monolith of masonry a proper foreground and setting. Before many years have passed, grass and trees and shrubbery will have grown up over the unsightly banks of "spoil" that were taken out and strewn down the valley while the big trench for the dam was being excavated. When nature has healed the scars, this noble structure will form one of the most impressive and beautiful scenes, of an engineering character, to be witnessed in any part of the world.

As one looks at the visible portion of the Croton dam, he is impressed with its immensity; yet it must never be forgotten that some two-thirds of the masonry lies buried below the surface of the ground. Although the great wall extends, roughly, 160 feet above the ground, it has to be carried down 140 feet below the ground to find the firm rock footing, upon which it stands so securely that its age will be as great as that of the rocks themselves. Moreover, to secure a wide enough base to prevent the mass from being overturned by the pressure of the water, its foundations had to be carried out over a space, measured transversely to the axis of the dam, of 206 feet. From the foundation the dam narrows to about 100 feet in thickness at the ground level, and to about 20 feet at its crest.

As the waters rose in the dam, they spread out far and wide over the Croton Valley, reaching back into the many valleys and cañons and forming a lake of remarkable beauty. The waters have backed up over the crest of the old Croton dam, some three miles up the valley, which is at present entirely submerged. When the reservoir is full, its surface will be 30 feet above the old structure. The gatehouse by which the waters are led away from the dam for use in New York city is located at the old Croton dam, on a bench, or platform, that has been blasted out of the rocky bluffs on the southern shore line. The water is carried to New York by the new aqueduct, which opens out of the old reservoir, with its invert, or bottom, at elevation 140. The aqueduct is 14 feet in height; consequently, in order for this aqueduct to take its full flow of about 280,000,000 gallons per day, the water must stand at elevation 154. Now, above elevation 154, when the reservoir is full, there will be contained a total of 24,000,000,000 gallons of water, and above elevation 140, at which water would begin to trickle into the new aqueduct, there will be 27,600,000,000 gallons of water. As the reservoir now stands at elevation 168, there are about 7,000,000,000 gallons of water in the reservoir above elevation 140.

It is a curious fact, by the way, that there are 6,000,000,000 gallons of water contained in the new reservoir below elevation 140, which can never be available. Adding this to the 7,000,000,000 gallons available, because lying above 140, we have 13,000,000,000 gallons as the amount now stored in the reservoir. Elevation 140 was the lowest elevation that could be taken to allow of a sufficient fall or grade over the 30 miles from Croton to New York city, to insure the water flowing in sufficient volume. It can be readily understood that every foot of rise, when the reservoir is nearly full, represents many times as much water as a foot of rise when the reservoir is low. As a matter of fact, the last, or upper, 15 feet of the reservoir contains about 14,000,000,000 gallons of water, or about half of the total contents of the reservoir when it is completely filled.

The Croton dam, when it is completed, will have taken just thirteen years to build. Ground was broken in August, 1892, under a contract taken by Mr. J. S. Coleman, and the work has been carried through to completion by the firm of Coleman, Breuchaud & Coleman, to whom we are indebted for many courtesies in preparing the various articles we have published on this work. Before the masonry dam could be built, it was necessary to excavate 1,750,000 cubic yards of earth, and the total rock excavation has amounted to 425,000 cubic yards. The total masonry in the dam and spillway will have amounted to 850,000 cubic yards. The original plans of this great work were drawn up by Chief Engineer Fteley. He was succeeded as Chief Engineer by Mr. Hill, to whom is due the important modification by which the earthen core wall portion of the dam was discarded, and the whole structure built of uniform section and materials throughout. The rapid completion of the dam is due to the present Chief Engineer, Mr. J. Waldo Smith.

The creation of the Croton Lake, which will back up the valley for nearly 20 miles, necessitated the reconstruction of many miles of roads, that will be submerged when the reservoir is full. The new roads have to be carried across several arms of the lake, and this has necessitated the construction of some long and costly bridges. The Hunter's Brook bridge has two spans of 217 feet and a main span of 310 feet. At the old Croton dam is a crossing consisting of a 124½-foot plate-girder span, and a noble truss of 396-foot span. At Pines Bridge is a beautiful cantilever with two 160-foot shore arms and a central span of 384 feet. The system of roads thus formed provide a most picturesque driveway of over 50 miles in extent.

Wanted: A Safe Explosive.

In this age of advancement, we are constantly called upon to remedy defects. We are striving for more powerful contrivances, aiming to attain the greatest efficiency in whatever direction, in whatever enterprise, in whatever invention, we are engaged. Our railroads are increasing their rolling stock, our electrical engineers are replacing steam power, our navy is contemplating augmentation, our engines of war demanding powerful explosives. But the railroads safeguard their traffic by reason of the block system; those employed in electrical work can insulate themselves; the perils of fire on shipboard can be overcome by using fireproof wood, also lifeboats and preservers; but where is the protection for the user of powerful explosives?

Where is there a safe explosive?

Premature explosions are heard of daily, with loss of life and property. Let us look into the properties of explosives. Guncotton possesses electrical properties, and the passage of a current of heated air over the explosive may generate enough electricity to set it on fire. Good dynamite is of a plastic consistency. It should not feel greasy to the touch. The density of it depends upon the "dope," which is the absorbing material. It embraces the physical properties of nitroglycerine, which is its chief explosive principle, and is equally poisonous. Its firing point is 180 deg. Centigrade, and at this temperature it either burns or explodes. When free from pressure or vibration, it burns; otherwise it explodes. The sensitiveness of dynamite to blows increases with the temperature; as Eissler says, "at 350 deg. Fahrenheit the fall upon it of a dime will explode it." When ignited in small quantities in the open air it burns with great vigor, but when larger amounts are ignited explosion invariably results. It freezes at 4 deg. Centigrade, and when once frozen it remains in this state at temperatures exceeding it. When frozen, it can be detonated only with difficulty and its force is weakened. It is true that all nitro-glycerine powders, when heated up gradually to the point of explosion, become extremely sensitive to the least shock or blow, and once that point is reached, they no longer simply ignite, but explode with great violence; and further, owing to the poor conductivity of the material, a small portion of dynamite in contact with the source of heat may reach this point and cause the explosion of the rest of the mass, which may be considerably below the danger point, as given by Walke.

Let us look into the cause of explosions. Abel has shown that while the detonation of guncotton would cause the detonation of nitro-glycerine in close proximity to it, the detonation of nitro-glycerine would not cause the detonation of guncotton. His theory of synchronous vibrations, which he states: "That the vibrations produced by a particular explosion, if synchronous with those which would result from the explosion of a neighboring substance, which is in a state of high chemical tension, will, by their tendency to develop those vibrations, either determine the explosion of that substance, or at any rate greatly aid the disturbing effect of mechanical force suddenly applied; while in the case of another explosion which produces vibrations of a different character, the mechanical force applied by its agency has to operate with little or no aid; greater force or more powerful detonation must, therefore, be applied in the latter case, if the explosion of the same substance is to be accomplished."

Romite, invented by a Swedish engineer, was the cause of thirteen explosions in various parts of Stockholm. These were due to "spontaneous ignition." Impurities in the guncotton may account for disasters, as in the case at Stowmarket, where over thirteen tons of compressed guncotton exploded. It is well known that dynamite, and for that matter all explosives containing nitro-glycerine, frequently explode through fall or friction. Experienced miners always drop the dynamite cartridge very gingerly into the bore hole, embedding it in fine, loose sand, that it may not be exploded by the manipulation of tamping. Not only is there great caution observed by users of black powder or dynamite in the coal mines before a blast is fired, but even greater danger presents itself when the explosive gives off large flames, setting fire to the coal dust and gases in the surrounding air.

We to-day demand an explosive that is insensible to heat and cold, that permits of safe transportation and rough handling, that will not freeze, insensible also to shock, concussion or friction, and likewise flameless.

A turbine-driven gas exhauster has been installed at Dover for the delivery of gas from a storage holder to two distributing holders 1½ miles distant. The steam turbine runs at 32,000 revolutions per minute and the exhauster at 4,000 revolutions per minute.

Correspondence.

A Simple Boiler Packing.

To the Editor of the SCIENTIFIC AMERICAN:

I have read several articles in your valuable paper on different kinds of packing for boiler manholes; and I would like to offer one, which for cheapness and simplicity, I believe hard to beat.

Take three pieces of strawboard—more often called pasteboard—about ⅛ inch thick, each piece about 3 inches larger than the manhole. Glue these together, making ⅜ inch thick, altogether, then with pattern of manhole (this pattern with about 1-inch rim can be sawed out of a thin board and kept for future use) mark the strawboard when dry, and saw out with scroll saw.

This packing will not shrink and split open like the ones made of wood. I have seen it used successfully for nearly two years.

An old boilermaker, who is now boiler inspector for this part of the State, told me it was new to him, consequently it must be new to a great many.

Lafayette, Ind., March 30, 1905. R. B. GREGG.

Determining the Date of Easter.

To the Editor of the SCIENTIFIC AMERICAN:

Those who are mathematically inclined will find the following determination of Easter day interesting. First, find the golden number by adding one to the number of the year and noting the remainder on dividing by 19. For example, dividing 1906 by 19, the golden number for the present year is seen to be 6.

Subtract the golden number from 20, multiply by 11, add 16 (add 15 only for the year 1899 and preceding years) and subtract a multiple of 30. The result gives the day of March on which full moon happens. The Sunday following the full moon that happens on or after the 21st of March is Easter day.

For the present year the golden number was seen to be 6. The product of 14 by 11, with 16 added, is 170. Subtract 120, and we have March 50 (April 19) as the date of full moon. By reference to a calendar, the 19th of April is Wednesday. Sunday, April 23, is Easter day for the year 1905.

Readers may practise the rule by showing that in 1818 Easter fell on the earliest possible date, March 22, and in 1943 it will occur on the latest possible, April 25. F. L. SAWYER MITCHELL.

Ontario, Canada.

The Intellectual Selection of Dogs.

To the Editor of the SCIENTIFIC AMERICAN:

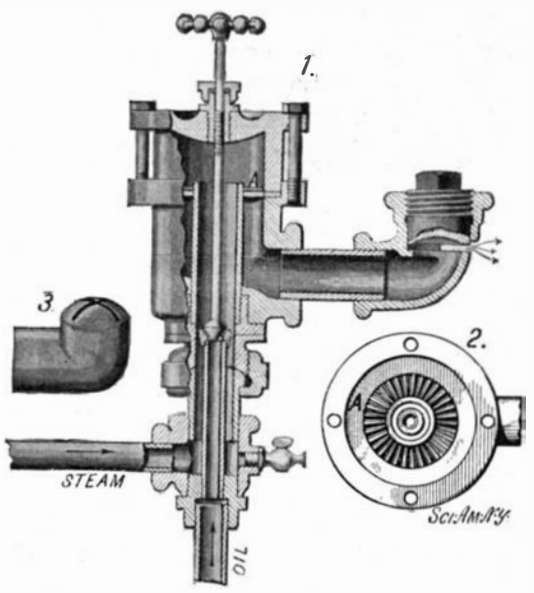
I was much interested in Mr. Washburn's criticism of Mr. Burroughs's article on the lack of intelligence in animals. One thing, however, I do not understand: Instead of being content with endless discussion of the matter, as in the time of Aristotle, why do we not resort, in this case as we do in other cases, to the experimental method? The cause of the divergence of opinion lies in the fact that the intellect of animals is exceedingly inferior to that of man, but the former can be raised by artificial selection. Why not apply it? Then we could easily see whether the gain consists only in increased reflex action, or whether there can be in animals anything like the complicated reasoning process which we witness in man. The dog would be a suitable subject for the experiment. That animal has been somewhat submitted to intellectual selection, especially by our prehistoric ancestors. In time of scarcity of provisions, man helped with a life-saving morsel mostly those dogs which were bright and affectionate. I have witnessed the process still at work among the numberless dogs of the *peons* of Spanish America. A selective process of another nature further improved our American dogs. Europeans notice that both dogs and cats are far tamer, brighter, and more affectionate in the United States than in Europe. It is evident that the average dog which, at the price of a pecuniary sacrifice and of some inconvenience, was carried across the ocean, was more loving and demonstrative than the average dog which was left behind. But all that selection was unconscious and thereby slow. Let some university found an institution for the intellectual selection of dogs. Let anybody who believes that he has an extraordinarily bright dog write to the institution, state the feats on which he bases his belief, and loan his dog for reproductive purposes. The careful selection of the offspring of such animals, their continual cross-breeding with all other available canine geniuses, would, after a dozen generations, create a race the form and color of which nobody can foresee, but the average intellect of which would probably be superior to that of any dog now living. That such a race would greatly help to solve many psychological problems is probable; that it would, in numberless cases, supply us with competent and faithful servants is certain.

GUSTAVE MICHAUD.

Springfield, Mass., March 22, 1905.

LIQUID FUEL BURNER.

In the accompanying engraving we illustrate an improved device for burning oil and other liquid fuel. The construction of the device is such that the oil will be thoroughly atomized and mixed with air and steam before reaching the burner. The mixture, it is claimed, will burn with a pure white flame entirely free from smoke. The oil is admitted through the vertical pipe at the bottom, and is heated by mixed steam and air, which enters through the horizontal pipe shown. Through a valve at the top of the oil pipe the oil passes in a thin conical stream into the air pipe, whence the combined oil and air pass up into the mixing chamber, striking the convex upper surface of the latter. From this point the mixture falls in a spray through the baffle plate *A*, which, as best shown in Fig. 2, is formed with radial arms and slots. In passing through this plate the oil and air are still further subdivided, producing a most intimate mixture of the two fluids before they pass to the nozzle of the burner. The nozzle consists of a slot cut into the outlet pipe. The thickness of the flame is regulated by a threaded plug, which may be screwed down into the pipe to close the slot to any extent desired. The mixing chamber is mounted to turn on the air pipe, so that the burner may be swung to any required position. The inventors have also designed a nozzle of the type shown in Fig. 3, which may be used to produce a vertical flame. We are informed that these burners have been put to a long practical test with heavy Texas oil, during which they were entirely free from choking. The device burns all grades of oil with equal facility, just enough steam being used to heat the oil and force the mixture through the burner. Owing to the simple construction, the apparatus may be readily taken apart for cleaning purposes or repairs. The inventors are



LIQUID FUEL BURNER.

Messrs. F. Richey and Thomas Daly, of 705 South Main Street, Paris, Texas.

The Duxbury Reef: A California Phenomenon of Singular Beauty.—Strange Curiosity of Bolinas Bay.

BY S. E. ST. AMANT.

Duxbury Reef, California, is familiar to people who seek the vicinity of Bolinas for hunting and fishing. It is not in the bay proper, but farther out, where it catches the force of the incoming breakers. Only when the tide is low can the reef be fully explored. Then its somber rocks rise to the height of sublimity. As the tide comes up, the reef seems to sink into the billows, until finally it is seen no more, and across its crest the waters pass unrestricted. The same is true of many a reef that mariners know and fear, but this reef is not of the common sort. It is not a pile of rock cast up only as a menace, but it seems to be connected with the fires that glow at the interior of the earth; a vent for the mysterious forces that press against the crust of the globe and thunder in the vast depths for exit.

The strata are similar to those of the mainland, being carbonaceous, interspersed with igneous rocks. A sticky substance exudes, that trickles down the little gullies, ever moving but deliberate as tar. This substance is inflammable. The touch of a match would set it in a blaze. But that the tides wash over the reef and clear it of the crude petroleum it would become so steeped in it that it would flare like a mighty torch, and, as cliffs on the coast of England have done, might smolder for ages.

There are human relics at Duxbury Reef, but they do not lend the strange spot any air of cheerfulness. At lowest tide there are exposed the timbers of a wreck, and beneath them are believed to be the bones of ten seamen, who perished when the vessel went down. Perhaps they had seen a beacon.

There are little fissures in many places on Duxbury Reef, where the strata have been wrenched apart. When fishermen visit the place they cook their meals over these fissures. They are not scientists, but they accept the facts of nature with imperturbable calm. They only know that on Duxbury Reef, where there is not a fagot or a pound of coal, fuel is provided without cost or trouble. They have only to apply a match to one of the fissures, and a steady blue flame appears.

They use it, and do not take the trouble to extinguish it. The waters do this for them. If the reef were only higher, its blue flame would be perpetual. But the tide is inexorable. It drives the fisherman back to his boat, and one by one it drowns the blue flames of his lighting.

There are traces of gold on Duxbury Reef. Once in a while prospectors visit it, and they never have trouble in finding color, but in a place that much of the time is under the sea there is scant chance for mining. The wealth of the reef must in all probability be found in some form of petroleum, or the products of nature always to be had where this material is abundant. When a match at a fissure in the earth starts a blaze that can only be put out by ducking, there is something worth investigation.

All this does not explain the beacon that flared and sputtered during the storm on Bolinas Bay. A party of prospectors had visited the reef. They had sat on its sterile outposts and caught gamy fish, which they fried over the fissures. They had marveled at the steady blaze, and in a wanton spirit of adventure had used matches here and there till the deepening twilight brought the reef into prominence. It seemed like an isle wreathed and crowned in fire. The fissures spurted flame. The dripping petroleum became tiny cataracts of flames. The very rocks glared with an incipient heat that awed the visitors. They feared that the reef would become a torch and themselves be consumed.

Yet there were bold spirits among them inclined to experiment. A piece of iron pipe was taken from the boat and driven deep into a hole. The spouting flame ran through it, and twelve feet higher than the highest light this place of lights had ever known a new beacon saluted the growing night and the gathering tempest. The prospectors left the reef and made for the shore. The tide climbed up and up. One by one the fires expired with a hiss and a steamy jet, but above the reach of flying surf the strange beacon remained. It was at this the people on shore looked with questioning eyes. They were accustomed to seeing the reef robed in fire, but the beacon puzzled and appalled them. The prospectors, too, watched. They saw the blue gleams die till the reef was not even a speck in the distance, and their beacon seemed a will-o'-the-wisp stranded.

Then it fell and was seen no more. The fury of the waves had undermined the pipe, and the fury of the wind had cast it down, while water had rushed into the enlarged fissures, and the last spark had gone out with an unheard hiss.

The men who had thrust the pipe into the fissure had a purpose. It was not to give the people of Bolinas something to stare at nor set mariners to searching their charts for a record of the light. They ascribed the possibility of igniting the opening in the reef not to the pressure of crude petroleum, but to natural gas that is often its accompaniment. They knew that at the discovery of such gas, factories and cities had sprung into existence. They knew that for heat and illumination, when it can be had, it is the cheapest medium ever discovered.

The tube proved this theory, but the reef is still untouched save by the sea fowl and the careless foot of hunter and fisher.

The Current Supplement.

The current SUPPLEMENT, No. 1528, opens with a scholarly and well illustrated article on the Mycenæan Palace at Nippur, by Clarence S. Fisher. The author shows the striking resemblance between the architecture of Mycenæ and of Nippur. Mr. R. Watson gives some very useful hints on pattern making. Carl George P. de Laval writes on "Pumping the Comstock Lode Mines." The effect of liquid air temperature on the mechanical and other properties of iron and its alloys is exhaustively treated by Sir James Dewar and Robert A. Hadfield. The recent experiments on the nature of magnetism conducted by Herr Zacharias are described and illustrated at length by Emile Guarini.

Approximation to Square Root of a Given Number.

A number between 10,000 and 100.—Divide the number by that multiple of 10 whose square is the nearest to but exceeds the number. Take one-half the sum of the quotient and divisor.

A number between 10,000 and 100,000.—Divide the number by 10/3 that multiple of 10 whose square is nearest to but exceeds in value 1-10 the magnitude of the half power of that which is desired. Take one-half the sum of the quotient and divisor.

Lead has recently been added to the list of effective ingredients of magnetic alloys, principally in connection with manganese and aluminium.

ALCOHOL FROM SAWDUST.

BY OUR BERLIN CORRESPONDENT.

A highly-promising process for utilizing saw-mill refuse has been developed by Prof. Alexander Classen, of the Aix-la-Chapelle Technical High School, in Germany. As the tests made in an experimental plant have given satisfactory results, an industrial plant where alcohol is produced from sawdust on a large scale has recently been erected in this country.

The production of glucose or sugar from cellulose, and its eventual conversion into alcohol, is a process by no means novel. In fact, this was done by Mr. Braconnet as early as 1819, by treating the cellulose with heated sulphuric acid. The sulphuric acid, however, being a liquid, could not be removed from the resulting solution without great difficulty, and only at an expense which rendered the process impracticable for industrial purposes.

Prof. Classen conceived the idea of using, in the place of the liquid sulphuric acid, gaseous sulphurous acid, as this will readily escape on the application of moderate heat, thereby leaving the treated wood practically free from any substances liable to prevent fermentation of the sugar therein. A plant for the manufacture of alcohol from sawdust includes an acid apparatus, in which the necessary solution of the sulphurous acid gas in water is made, and where the gas when escaping from the boiler or digester is reabsorbed in the water, and thereby saved for further utilization; a revolving boiler or digester similar in construction to those used in making chemical pulp; an exhausting battery, consisting of a series of tanks through which water may be passed, and in which the sugar that has been produced in the digester by the sulphurous acid gas may be washed out; neutralizing vats, in which the various acids in the solution are removed or neutralized by the addition of carbonate of lime; and finally, fermenting and still rooms, where the process is completed exactly as carried out in an ordinary distillery.

The sawdust is thoroughly mixed with the sulphurous acid gas and water, thus converting a portion of the cellulose into sugar. This sugar, of which about 85 per cent is fermentable, remains in the sawdust, which is then introduced into the exhaustion tank. Here the sugar is simply washed out.

The digester or boiler in which the wood is first treated consists of a revolving drum of iron, lined with lead to resist the action of the acid, and surrounded with a steam jacket, by means of which it is heated. This drum is nearly filled with sawdust. In the experimental plant one charge consisted of about 400 pounds of the material. To this is added a weight of the acid solution equal to about one-third of that of the sawdust. The steam is turned into the jacket and the drum set to revolving slowly, in order thoroughly to mix the contents. The steam in the outside jacket heats the contents of the digester to a temperature of approximately 295 deg. F. The gas is driven out of the water into the wood, so that it is caused to act directly on the cellulose, converting it into sugar. The pressure inside the digester, due to the expansion of the gas, rises to 100 pounds or more to the square inch. This part of the process lasts three hours.

The sulphurous acid gas and steam are then blown off from the cylinder into absorbing tanks in the acid room, where 75 to 80 per cent of the gas is saved, and may be used again. The digester and the surrounding steam jacket having been blown off, the cover is removed, and the digester is emptied of its contents, which now resemble ground coffee. This material contains the wood fibers and the converted cellulose, now sugar, and various other separated or partially separated products produced by the action of the acid and the heat on the wood. The process is not carried out as far as it is in pulp making, to which it bears some similarity. The object is to convert only as much of the cellulose into sugar as is practicable, and to bring the process to a stop short of a point where the sugar would be destroyed by a reversion.

The digester shown, while a somewhat crude arrangement mechanically, contains all the essential connections and accessories. The gages are used for recording the steam pressure in the jacket and the pressure on the inside of the drum, and the temperature of the same. There are pipes for introducing the gas and the steam, and blow-off pipes for the same.

In the experimental plant the exhaustion battery, as the outfit for washing the sugar from the sawdust is called, contains ten tubs or vats capable of holding 36 gallons each. It may be said here that in the commercial plant, it is proposed to handle a long ton of dry sawdust at a time, and the digesters and exhaustion batteries will be proportioned according to this supply of sawdust or other finely-divided wood. Sawdust is considered the best material, but particles of wood up to a quarter of an inch cube, or a quarter of an inch thickness, if in chip shape, appear to be treated as successfully as the former. Each of the tubs in the exhaustion battery in a plant of commercial size would be enlarged to agree with the increased size of the digester. They will be of a different shape from those shown in the illustration, being higher and smaller in diameter in proportion to their height. It is now thought that this should be about nine feet, the diameter five.

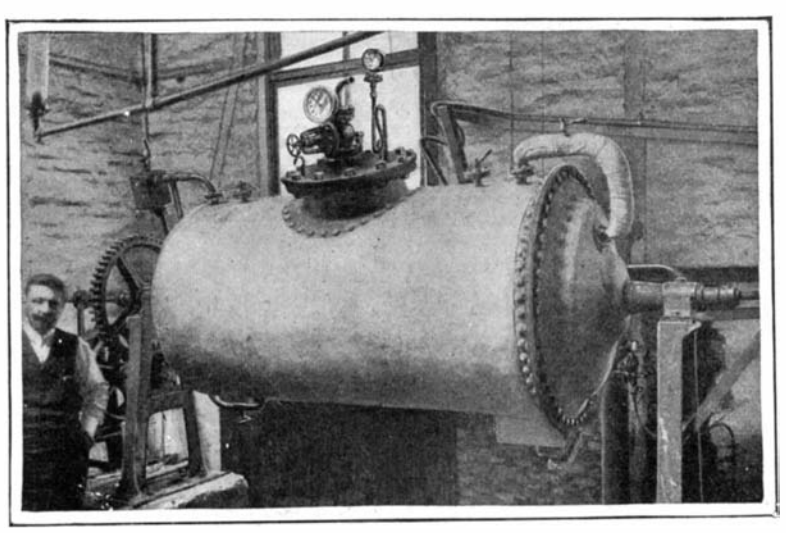
These vats are so connected by pipes and valves with each other and with the pump, that the contents of any one tub can be emptied into any other. The principle of this part of the process is to bring the sawdust in contact with the solution already containing sugar, in order to make the solution as strong as possible, and further, to treat the nearly exhausted sawdust with pure water in order to complete the washing thoroughly. The process is continuous, and when the contents of a vat has been treated with ten washings, it is emptied out and refilled with fresh sawdust. Just before emptying, its charge receives fresh water, and after refilling, receives the strong sugar solution.

The result of this process is a solution which contains 450 to 500 pounds of sugar from a long ton of dry sawdust. This sugar is of two kinds, pentose, which is non-fermentable, and the other, amounting to 70 to 80 per cent, capable of alcoholic fermentation when treated with yeast. The solution from the exhaustion battery is pumped into a receiving tank, where it is neutralized with carbonated lime. This is necessary to prevent the acids, either the remains of the sulphurous acid, or certain acids derived from the wood itself, from killing the yeast which is later added for the purpose of fermentation.

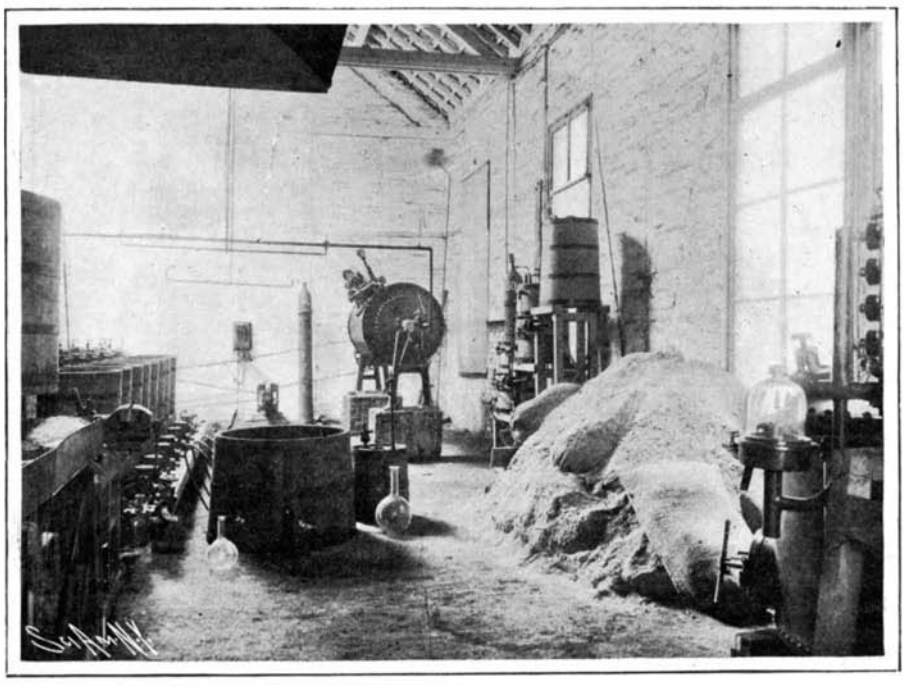
From this neutralizing tank, the solution is pumped into a fermenting vat. To the solution, now called "mash," yeast is added. It is kept constant at the proper temperature, and fermentation commences in a very short time. When it is completed, the product passes to the still room, equipped with still condensers, etc., as shown in the illustration. As aforesaid, this part of the process is in no wise different from that ordinarily used in distilleries. The result is about 50 gallons of crude alcohol or 25 gallons of absolute alcohol from a long ton of sawdust.

The improvement in the output has been so constant that it is believed that in time the further development of the system will enable the manufacturer to obtain 30 gallons, and perhaps more, from a ton of sawdust; but the results obtained so far are quite sufficient to secure the entire approval of scientists and of practical men who are familiar with the manufacture and marketing of grain alcohol. Comparing the original cost of sawdust with that of grain, and the output of alcohol from the former with that from the latter, it seems that the new process is destined in time entirely to supersede the older one.

One of the most important features of the process is the utilization of the sawdust after leaving the exhaustion battery. While passing through the various stages of the process it contracts in volume from 25 to 33 per cent, while volume for volume its fuel value is apparently unchanged. As a matter of fact, apart from the cellulose which is removed, no other component having a fuel value has been taken out. If it is desired to use the sawdust as a fuel, it can accordingly be turned back to the mill and burned under the boilers after treatment, thus retaining the original intention. The residue, however, retains unchanged and practically undiminished in quantity such components as make it available for dry distillation. The treatment by heat and acid has left it dead and without apparent elasticity. It can consequently be pressed into briquettes without the use of a binder, and this in itself is an exceedingly valuable property.



Digester for Converting Sawdust (Cellulose) Into Glucose (Sugar).



The stills and apparatus for preparing sulphurous acid are seen at the right.

General View of the Aix-la-Chapelle Plant.

At the right: Exhauster for extracting sugar formed in digester. At the left: Alcohol stills.

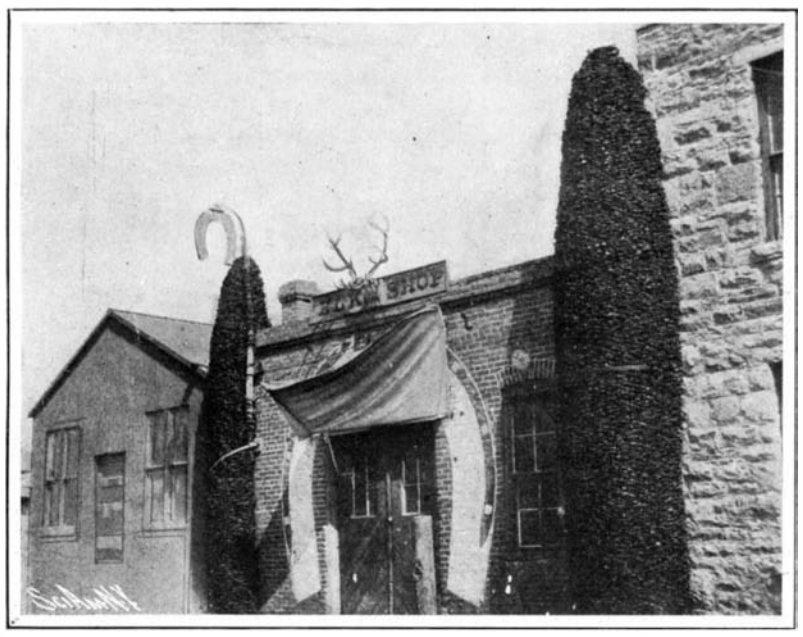
The Aix-la-Chapelle Experimental Plant.

The first award of the John Fritz medal, which was established by the professional associates and friends of John Fritz, of Bethlehem, Pa., on August 21, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress, has been to Lord Kelvin.

A COLUIIN OF HORSESHOES

In the town of Fort Collins, Col., the village blacksmith has created a curious but very appropriate sign. In fact, it represents not only his industry, but the many years in which he has been engaged in it. As the illustration shows, on either side of the entrance to the shop are pillars, which rise several feet above the roof. From a distance they resemble box trees with the branches closely cut, to give them an ornamental appearance. As a matter of fact, the columns are composed of discarded horseshoes. As each is fully thirty feet in height and five feet in diameter, a faint conception may be obtained of the immense number of shoes utilized in constructing them, for each column was built up by laying the shoes one upon the other with their flat sides in contact. Through the center of each column runs a wooden post, and the novel structure has been formed by wiring the shoes to it.

The construction of the signs was begun when the shop was opened for business. The columns have become too heavy to be increased in height, and are anchored by iron bands to the walls of the building.



A COLUMN OF HORSESHOES.

THE GIANTESS ROSA WEDSTED.

The subject of the accompanying illustration is a Finnish maiden of twenty-four years, Rosa Wedsted, native of a village near Helsingfors. She has already attained the respectable height of 7 feet 2 inches and is still growing.

Neither her parents nor any of her four sisters and brothers are above the average height, and until her sixth year no intimation was given that she would exceed the stature of the normal human being. From that year she made rapid progress, and by the time she had reached her fourteenth year she had attained to the astonishing height of 5 feet 7 inches. Since then she has been mounting upward slowly, having in the last ten years added about 1 foot 7 inches, with undiminished tendency skyward. The peculiarity concerning her growth seems to be limited almost exclusively to her lower limbs. She possesses an extraordinary length of leg, while the rest of her body and arms seem to have extended but mildly in comparison.

Inoculating Material for Leguminous Crops.

The erroneous statements which recently appeared in the public press regarding the free and unlimited distribution of inoculating material for leguminous crops is likely to cause those who apply for these cultures to be disappointed. The publication of the results obtained with pure cultures in inoculating leguminous plants has resulted in such a demand for this material that the facilities of the Department of Agriculture have been taxed to their utmost. It has been impossible to meet the demand; in fact, the total quantity which could be prepared this season was promised early in February.

The patent which the Department holds upon the method of growing and distributing these organisms was taken out in such a way that no one can maintain a monopoly of the manufacture of such cultures so as to permit of its being taken up and handled commercially. The commercial product is being handled quite generally by seedsmen. Upon application the Department has furnished all necessary information to the bacteriologists representing properly equipped concerns, but it cannot assume to make any statement which could in any way be regarded as a guarantee of the commercial product; nor is it prepared to indorse each and all of the somewhat extravagant claims occasionally made for this discovery.

A SPONTANEOUSLY-MOVING STONE BALL.

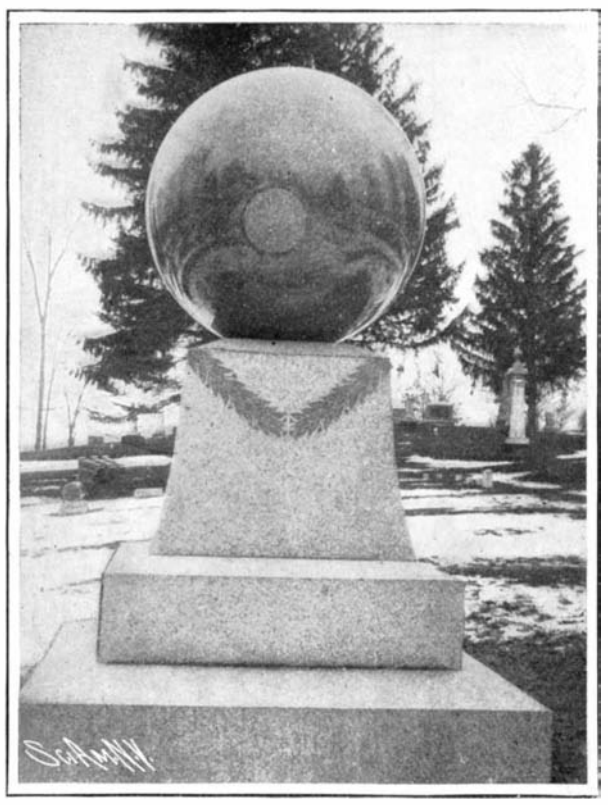
In the principal cemetery of Marion, Ohio, there is a monument which has attracted a great deal of attention for some time. It consists of a large stone ball, 36 inches in diameter, resting upon a heavy pedestal. This ball is slowly turning upon its base, revolving about a horizontal axis in a direction from north to south, presumably by the action of the sun's rays.

The monument was erected a number of years ago by Mr. C. B. Merchant, a local banker, but it was not known that it was turning until the spring of 1904, when the cemetery employes noticed that it had apparently shifted a little. Since that time it has been watched and measured repeatedly, and it is established beyond question that the stone is turning continually.

The ball was never securely fastened to the base, but the unpolished spot seen in the illustration was set in a socket, and it was supposed that the friction of the two rough surfaces would be sufficient to prevent any displacement. At the present time, however, the rough spot is nearly half-way to the top on the north side, and has moved over five inches since the first of August. There is very little chance for the perpetration of a hoax in connection with this interesting phenomenon, as the ball weighs 4,200 pounds, and would require extensive machinery to move it.

A number of theories have been advanced to account for the cause of this natural phenomenon. State Geologist Edward Orton, Jr., in a letter to a member of the cemetery association, says that the rotary movement is probably due to two causes. First, the ball becomes more heated than the heavy base, and consequently expands more, giving rise to a slight creeping. The ensuing contraction might not be sufficient to take up the displacement caused by the heat in the earlier part of the day. Secondly, we may regard the circumference of the sphere as lengthening out on one side, and giving rise to a pulling stress between the ball and base upon which it rests.

Prof. Becker, one of the head physicists of the Geological Survey, and Prof. Gilbert, who is probably the most prominent geologist in the Survey, have been consulted upon this question, but without very satisfactory results. Both were uncertain as to the cause of the rotation of the sphere, save that there could be no doubt that it is attributable to the action of the sun's rays. Prof. Becker said that if the rotation were from south to north, instead of being, as stated by our correspondent, from north to south, he could more easily understand the case, for then expansion of the sphere itself would be on the south side chiefly, so that leverage would be applied on that side, which might raise the ball there, causing it to slip downward correspondingly on the north side. Prof. Gilbert suggested that there might be a difference between the cup-shaped socket and the sphere, with a correspondingly imperfect fit and unequal friction on the two sides.



Since this photograph was taken the ball has rotated 14 inches eastward.

A BALL OF STONE THAT TURNS SPONTANEOUSLY ON ITS PEDESTAL.

From the illustration it appears that there is a large evergreen tree not far from the monument, and apparently directly to the south of it. It has been suggested that the monument is thus partly shaded at times, or for a portion of the day, and that there is some connection between this fact and the rotation. At present, despite all these theories, there seems to be no satisfactory explanation, and the phenomenon will probably remain unexplained until it has been under close scientific observation for a lengthy period of time.

THE GIANTESS ROSA WEDSTED.

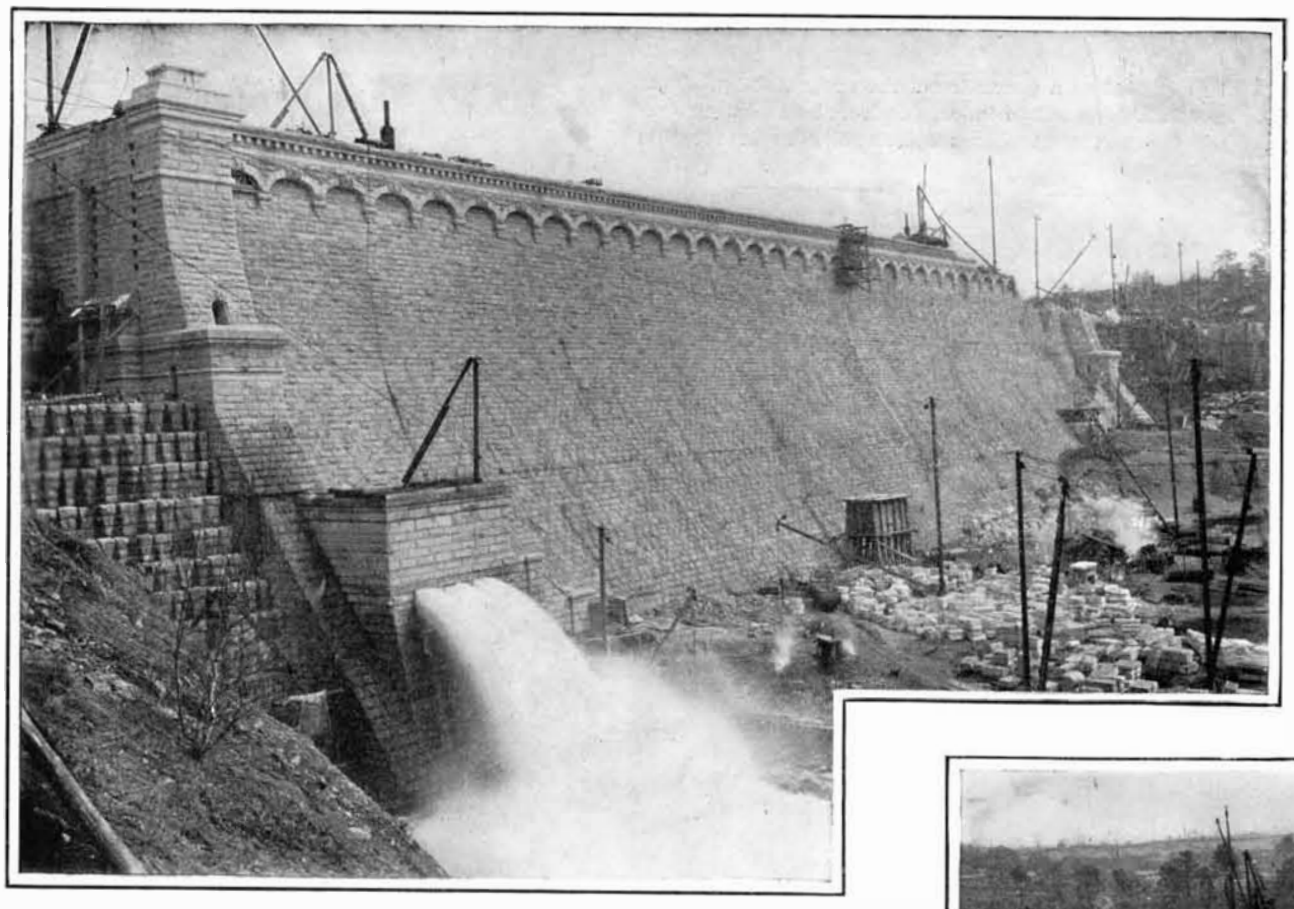
Luminous Phenomena of the Human Skin.

In a recent issue of the Deutsche Medizinische Wochenschrift Prof. Sommer records some interesting observations made by himself on a luminous effect produced after rubbing the human skin on incandescent lamps. While grasping a small electric lamp one night, the professor happened to observe that on contact with his hand the bulb of the lamp would show a luminosity comparable with a mist of light, illuminating certain parts of the glass as well as his fingers, even before the electric current was completed. This remarkable phenomenon could be produced several times by rubbing the electric bulb with the hand. It should, however, be mentioned that not all electric bulbs are suitable for the experiment and that those which have been used for some time and showing the well-known dark coating of carbon particles are especially apt to failure.

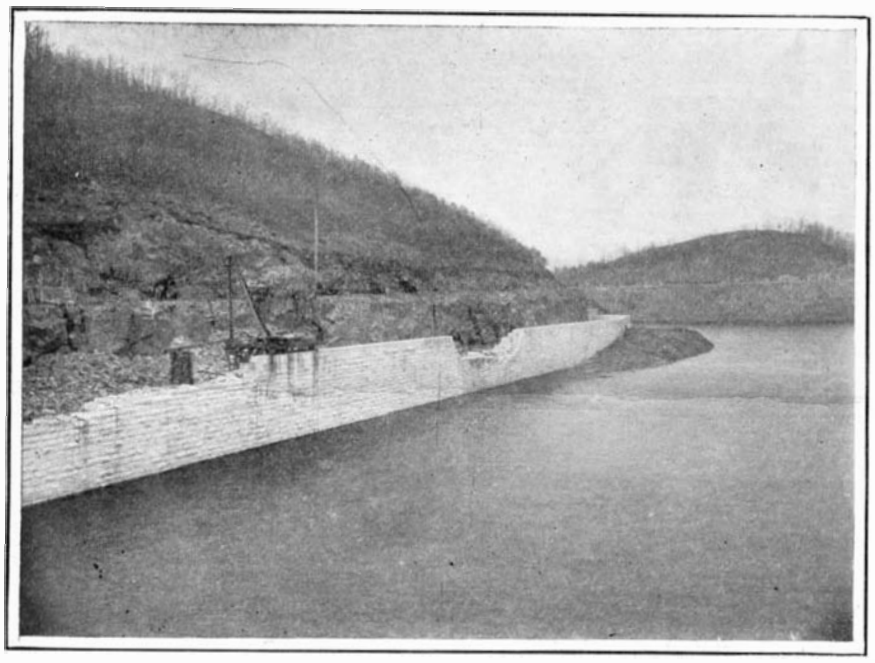
When rubbing a new or nearly new lamp, containing no metallic conductors, strongly on the skin of the forehead or lower arm, and withdrawing the lamp suddenly from the skin, the bulb will show the luminous phenomenon. When withdrawing the lamp and stopping it suddenly, its outlines stand out distinctly illuminated, while in the middle a bright spot is observed.

If after rubbing the lamp on one part of the body (e. g., the lower arm) some other part as the cheek be touched with it, the contact will even without any friction result in a luminosity lighting up part of the face. When breathing strongly on a lamp that has been rubbed over some part of the body, a distinct luminosity is produced.

According to Prof. Sommer the phenomena in question would be partly of a physiological character, that is to say, belonging to the human or animal organism. On continuing his researches, he detected the photographic action of the luminosity, and as part of the same phenomena can be obtained also by friction on other substances, they would seem to be partly due to some general physical law.

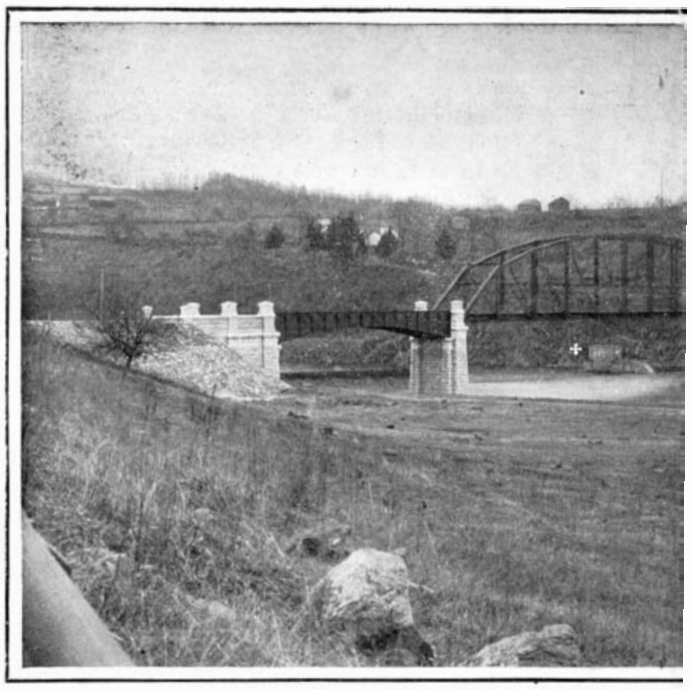


Downstream View of Dam, Looking Southeast.

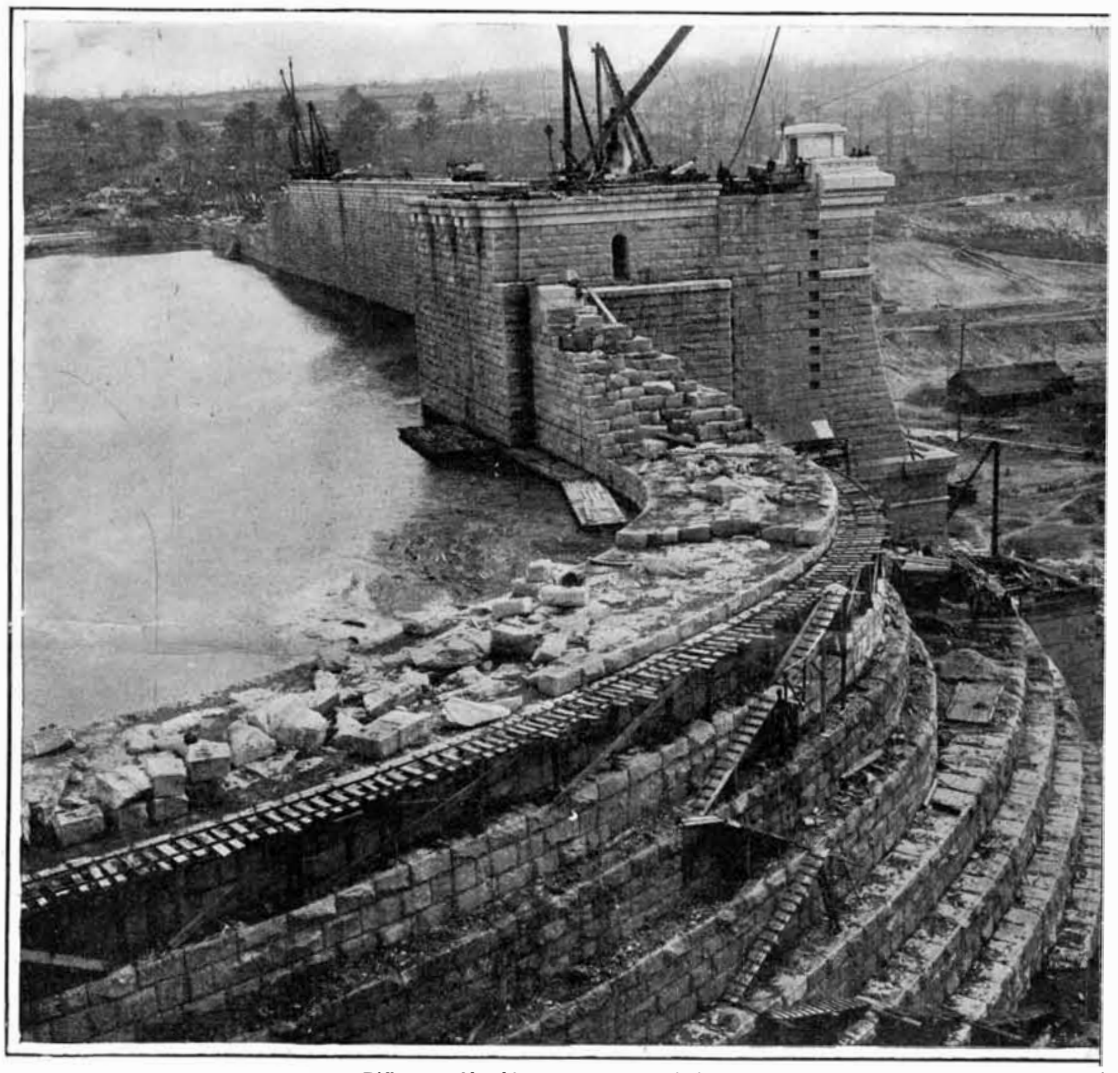


The finished crest marks the high-water level of the Reservoir.

The 1000-Foot Spillway, Viewed from the Lake.

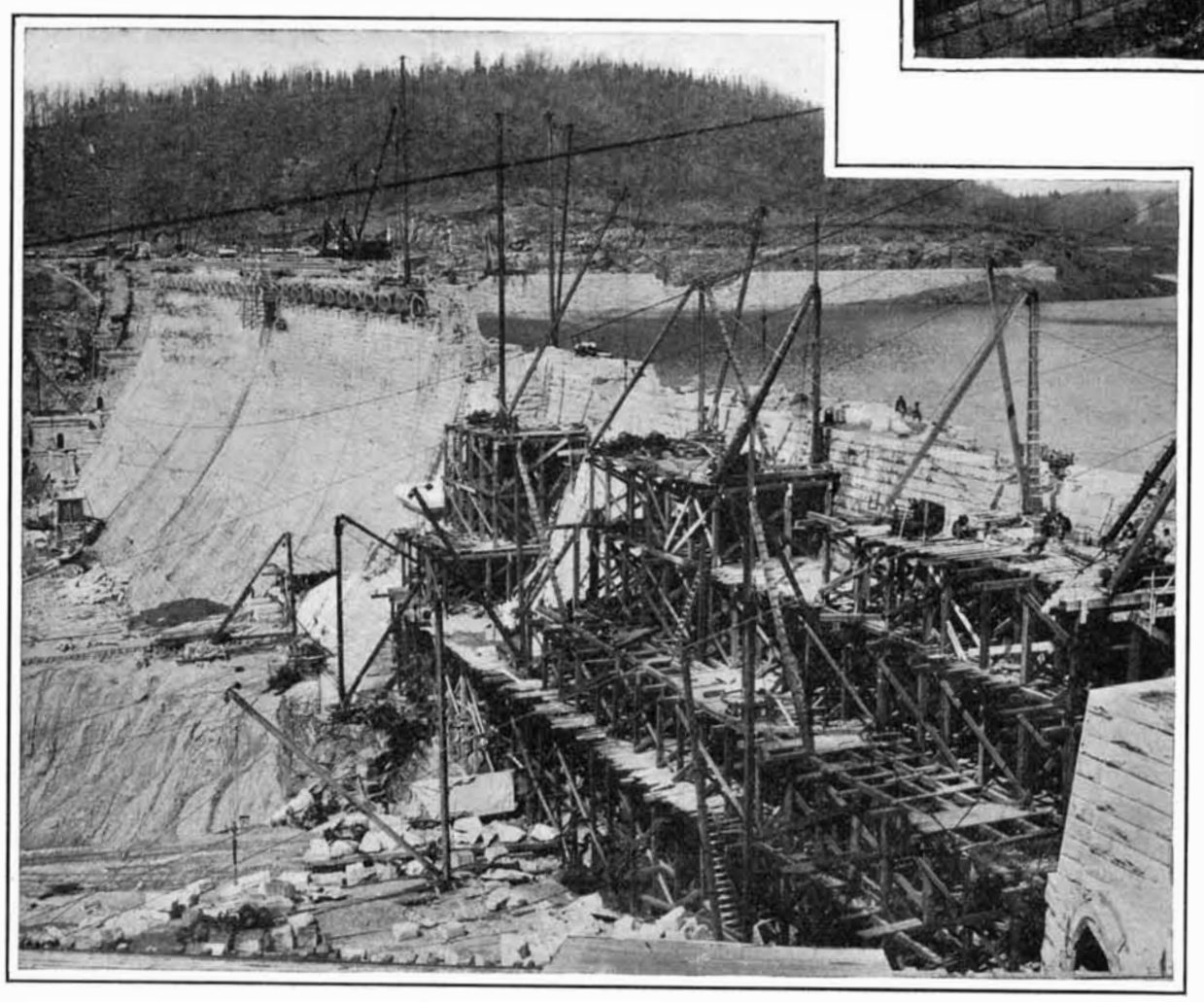


New Steel Highway Bridge and New Gatehouse at Old C

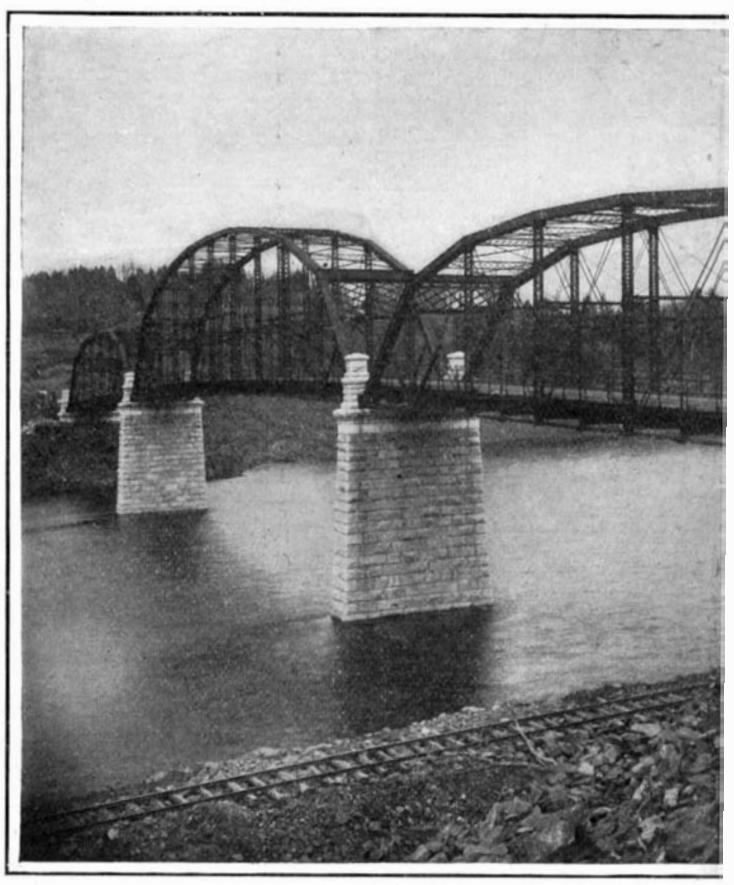


Difference of level between the water within the dam and the river at its toe is 120 feet. All t

Looking Down the Croton Valley fr

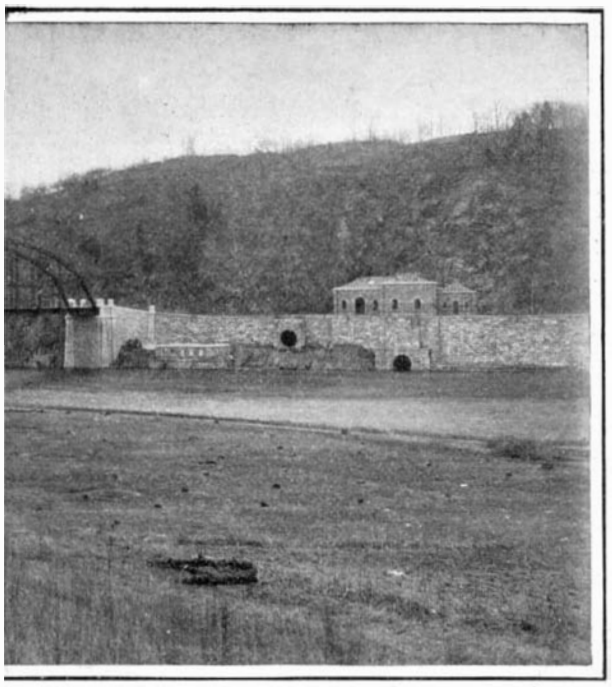


The Uncompleted Southerly Portion of the Dam; Takes Place of Original Earth-and-Corewall Section.

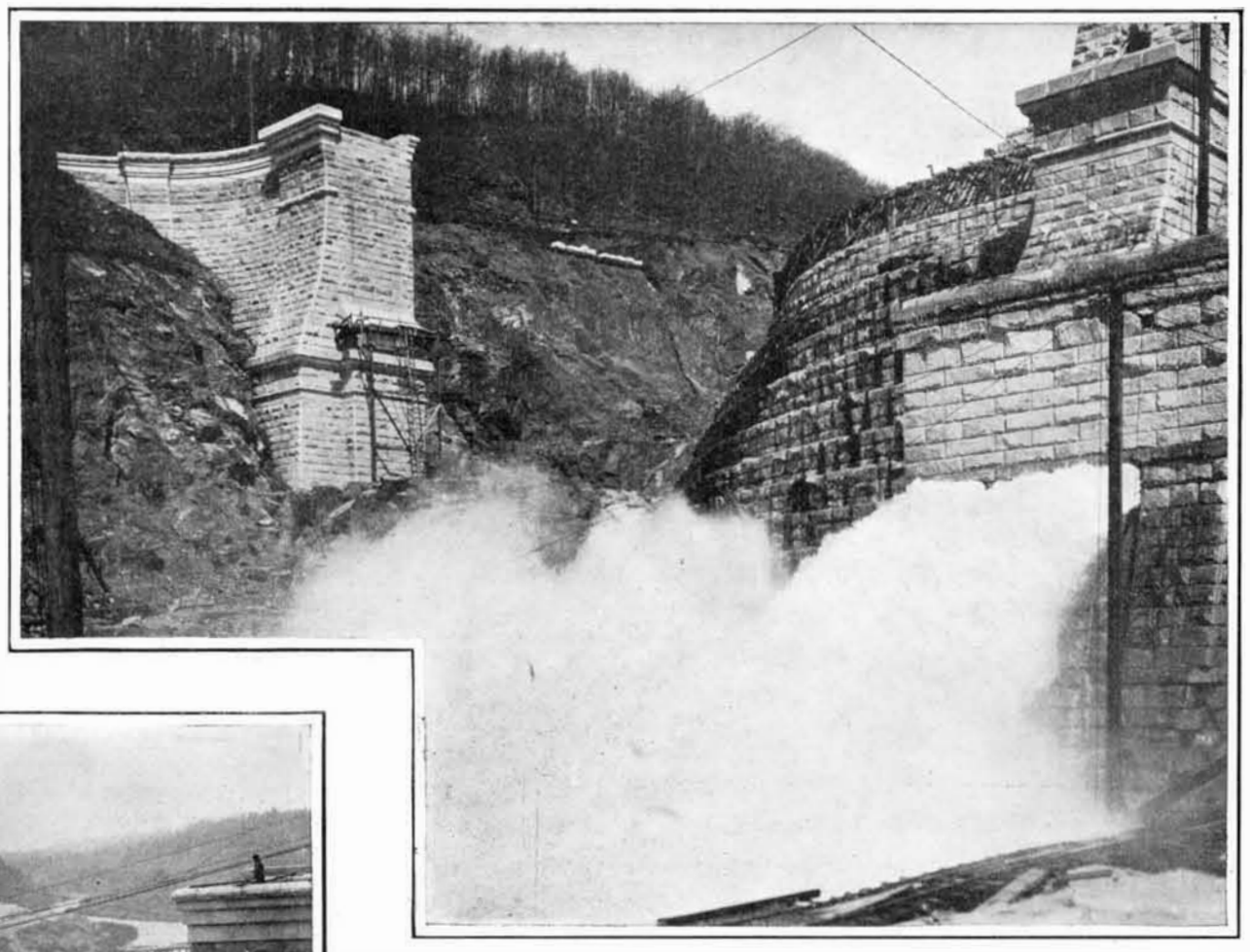


New Bridge Built to Carry the Highw

CLOSING OF THE CROTON DAM. BUILT FOR T

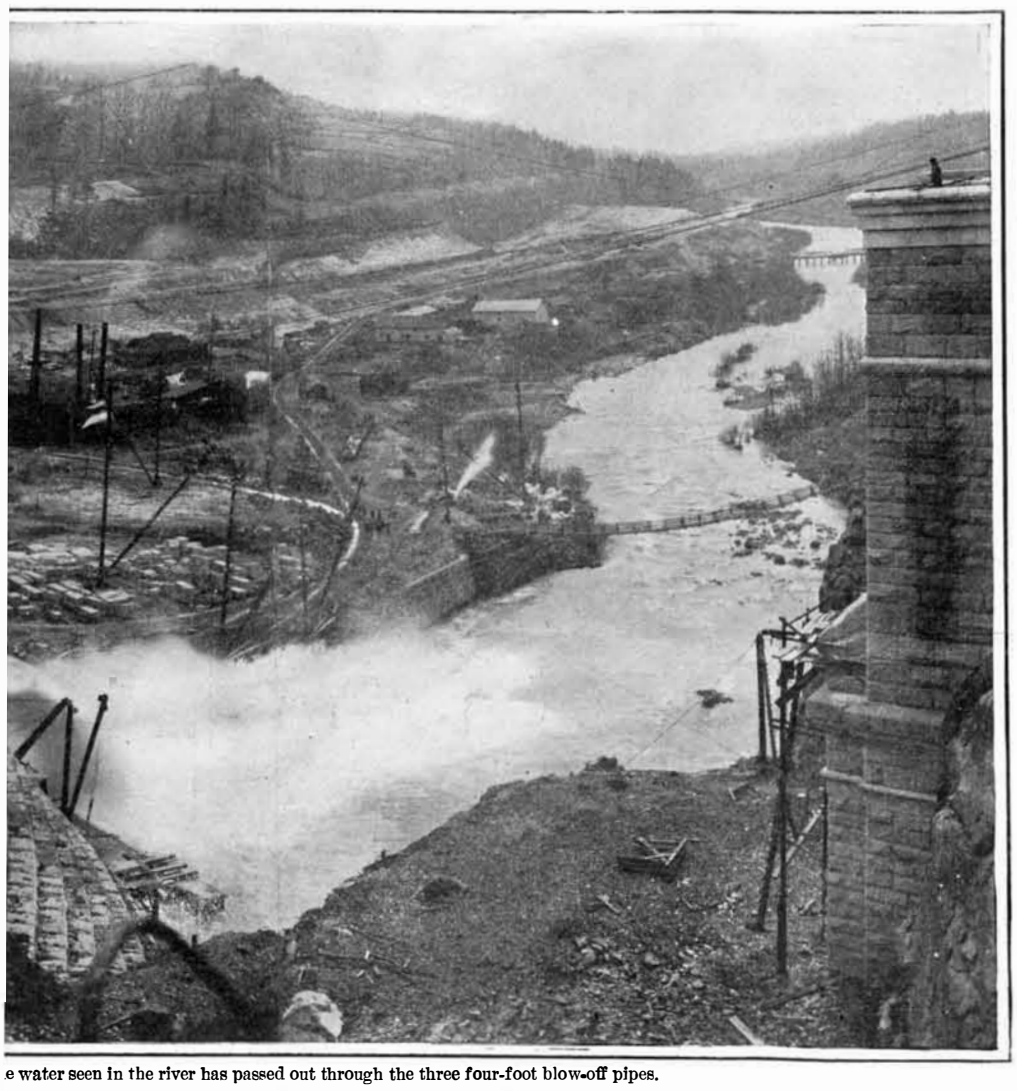


roton Dam. Cross Marks Site of Submerged Dam.



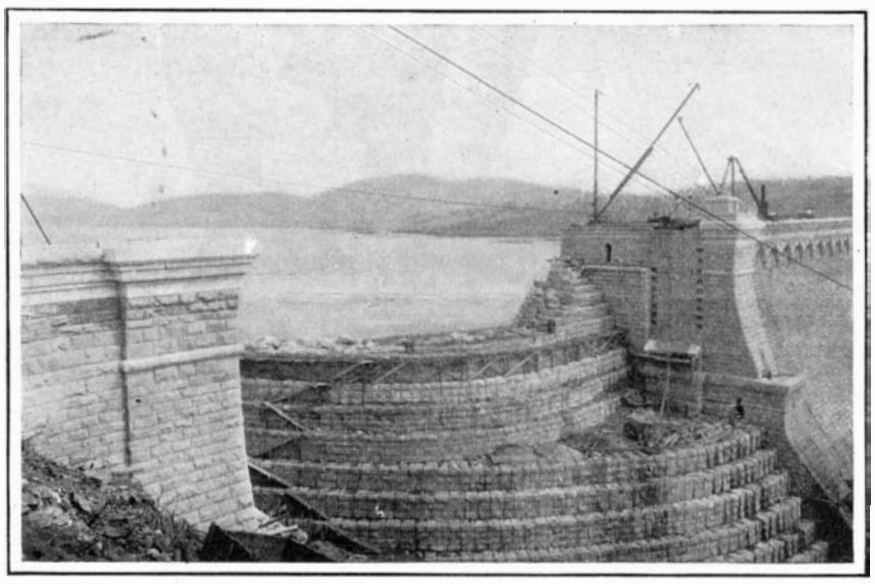
One billion gallons per day are passing through the dam.

Looking Northeast Through Spillway Gap.

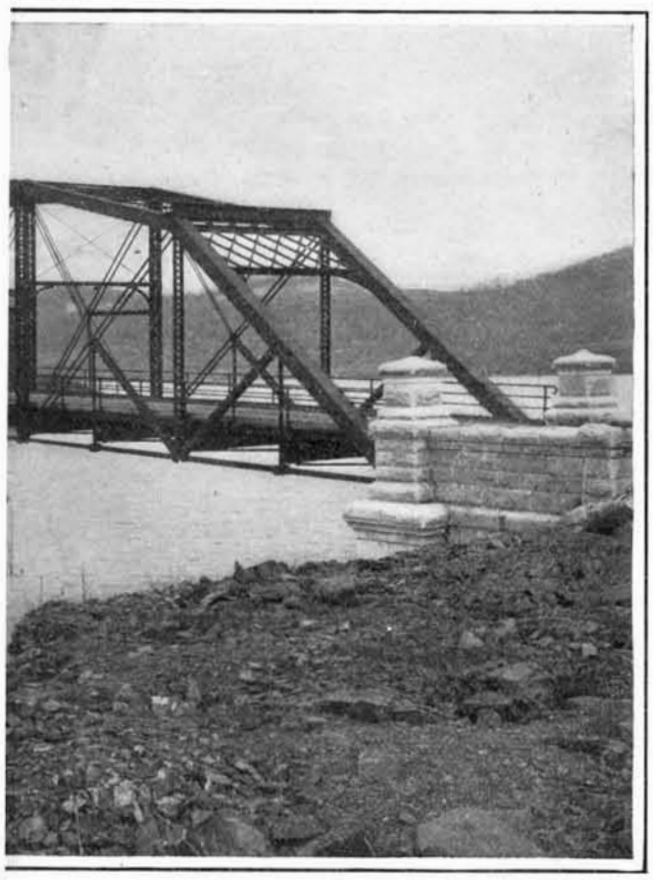


e water seen in the river has passed out through the three four-foot blow-off pipes.

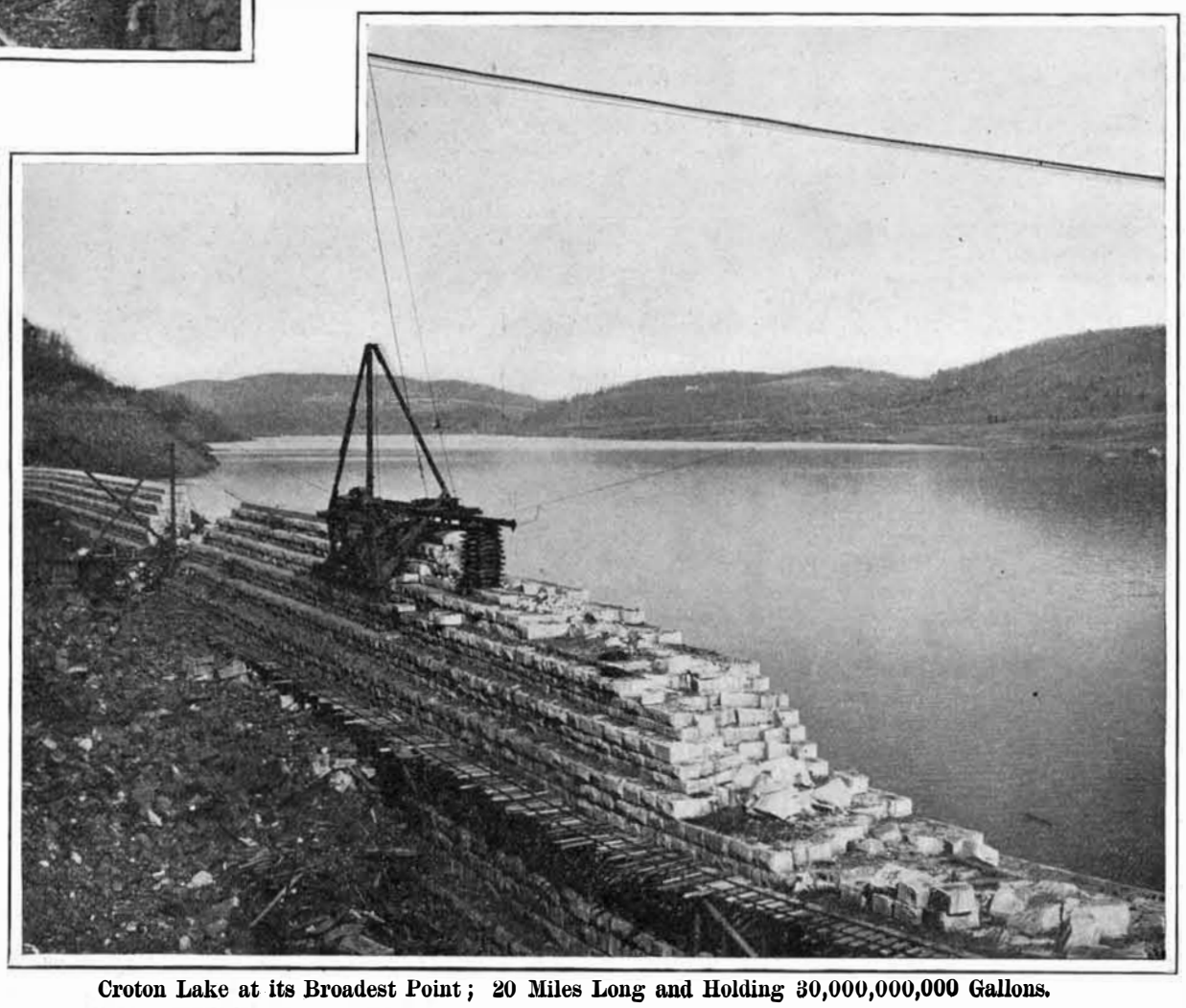
m the Crest of the Spillway.



A Glimpse of the Reservoir Through the Spillway.



y Across an Arm of the Reservoir.



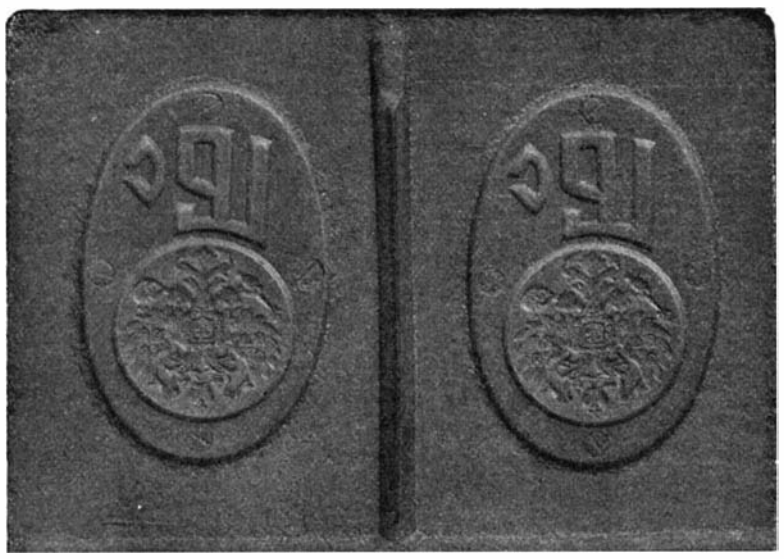
Croton Lake at its Broadest Point; 20 Miles Long and Holding 30,000,000,000 Gallons.

HE WATER SUPPLY OF NEW YORK CITY.

CONCENTRATED TEA SLABS.

BY L. LODIAN.

Compressed tea is common enough in Siberia, but so far as I know an unknown commodity in this country. It is an ordinary black tea, which is very widely



SLABS OF TEA USED BY THE RUSSIAN ARMY

used by the Buriats of the trans-Baikal region, by whom the herb thus prepared is drunk, flavored with salt and sour cream. Sugar would be preferred, of course, but it is either unattainable or too high-priced, costing, as it does, from seventy-five cents to one dollar a pound.

The specimen of compressed tea that is here pictured is of a very good quality. Just now it is of interest because it is used by the Russian officers in Manchuria. The tea is compressed by superb modern machinery, evidence of which is afforded by the splendid specimen of die sinking on the tablet itself. Such has been the pressure employed, that the formerly soft and yielding leaves assume the appearance of a hard tile, which can with difficulty be cut with a knife. As a general rule, a mallet or hammer is used to break off a piece, very much as if the tablet were of stone.

The tea employed is a straight Suchong, which needs no cream because nature has given it a slightly creamy taste, and also one that is feebly saccharine, so that it requires less sugar than other teas. In flavor this compressed tea cannot be compared with the natural herb. It is much flatter in taste, but possesses the same stimulating properties. A piece the size of a thimble is sufficient for a large, strong cup. No teapot is necessary. Scalding water is poured on the nugget in the cup, and in a few minutes the tea is ready.

No cementing agent whatever is used in compressing high-grade teas—not even sugared water nor artificial heat. The little heat that is generated in compression starts the tannic acid in the leaves, which is all the adhesive required to hold the block together. A tablet thus compressed may be exposed to soaking rains with little danger of injury. As a general rule, however, compressed tea is kept in worsted bags.

The official Russian compressed tea, of which the tablet here illustrated is a sample, is not obtainable in Europe outside of Russia.

A CURIOUSLY DISTORTED LOCOMOTIVE.

Two trains figured in a collision near Suisin, Cal., in which one engineer was killed and both locomotives slightly damaged. The front end of one of the damaged locomotives was driven in. When it was taken to the repair shop, some mechanic with a sense of humor saw his chance for playing a joke. With a few chalk lines he gave the wreck a weird, dragon-like appearance, which is excellently shown in the accompanying photograph.

Gilbert's "De Magnete."

An unusual circumstance has arisen in that two different London booksellers are offering for sale copies of the rare Latin first edition of Gilbert's famous book. This book is much rarer than the first folio Shakespeare, for while of that work no fewer than 156 copies are known to exist, there are only 68 copies of the first folio Gilbert known, and only two have been sold in the book auctions during the last twenty years. On the last occasion, nearly three years ago, an inferior copy fetched £15 10s. A year ago a West End bookseller offered a copy at £24. Now Messrs. Maggs Bros. offer a copy at £19 19s., and Messrs. H. Sotheran & Co. another copy, formerly in the library of the late Prof. Williamson, at £21. This latter is a remarkably fine clean copy with broad margins, the page measuring 11½ inches by 7¾ inches. It has the usual emendations in ink on pages 11, 22, and 200; but as it lacks the usual emendation on page 47, where "Non" is altered into "Aut," it is presumably an early copy from the press. The title page is clean and free from any inscriptions. It is to be hoped that this copy will be secured for some British library, and not pass, like many literary treasures, into foreign hands.—Electrician.

A VERY RARE BRONZE CASTING.

BY J. MAYNE BALTIMORE.

Mr. Andrew Rudgear, a wealthy art connoisseur of San Francisco, Cal., has recently brought from Europe a magnificent bronze door which has attracted wide public attention. It is not divided into panels, as is the case with some of the famous bronze doors of the best period of Florentine art, but apparently is cast in one whole piece, the subject being a wild rout of Bacchus. The upper portion is occupied by dancing nymphs and Mænads, or bacchantes. The center female figure holds aloft a wine cup, and presents a most graceful attitude of abandon to the spirit of the grape and the dance.

The lower portion is similar in character, though more sedate in action. The center of the door consists of a satyr led in bonds by roystering bacchantes. These figures are in strong relief, the satyr bending forward, his feet resting upon a garland of flowers and clusters of grapes, which carry the decorative motive to the sides, where two other bacchantes are bearing vases of fruit.

The composition is exceedingly bold and free, a great many figures being employed; some holding aloft the thrysus, or staff, entwined with ivy and surmounted with a pine cone; others entwining their arms and bending in the dance, standing out from the background almost completely detached; while others, with pipe and cymbal, disappear amid the profuse ornamentation of scrolls, vines, and flowers. Still, there is no confusion in the design—everything lending itself to the general effect of graceful movement and decorative unity.

The casting of this door is not the least part of its attraction. The modern method of casting bronze by piece molds is pretty generally understood; and almost anyone may perceive the great technical difficulties of casting such a large and very intricate work as this door. It is quite probable that what is known as the *cire-perdue* or wax process was used. A more careful examination of the bronze, and especially of the back, which at present is covered by the wooden part of the door, may throw more light on the subject.

So far as its origin or date of construction is concerned, there is every reason to believe that it is of very considerable antiquity—belonging to the fifteenth or sixteenth century. The surface, or *patina*, has taken on a beautiful hue of mingled green, dark brown, and gold, proclaiming its age and adding to the general effect.

Just how Mr. Rudgear came into possession of this treasure of art is quite interesting and—accidental. He was traveling through Italy. When about twenty miles outside of Florence, he came upon some workingmen who were wrecking an old villa. While talking to them, he incidentally learned of the bronze door that had been stored in the cellar.

He immediately entered into negotiations, which resulted in its purchase. As the government is determined to allow as few as possible, if any, rare works of art to leave the country, Mr. Rudgear had much trouble in securing his beautiful treasure from the

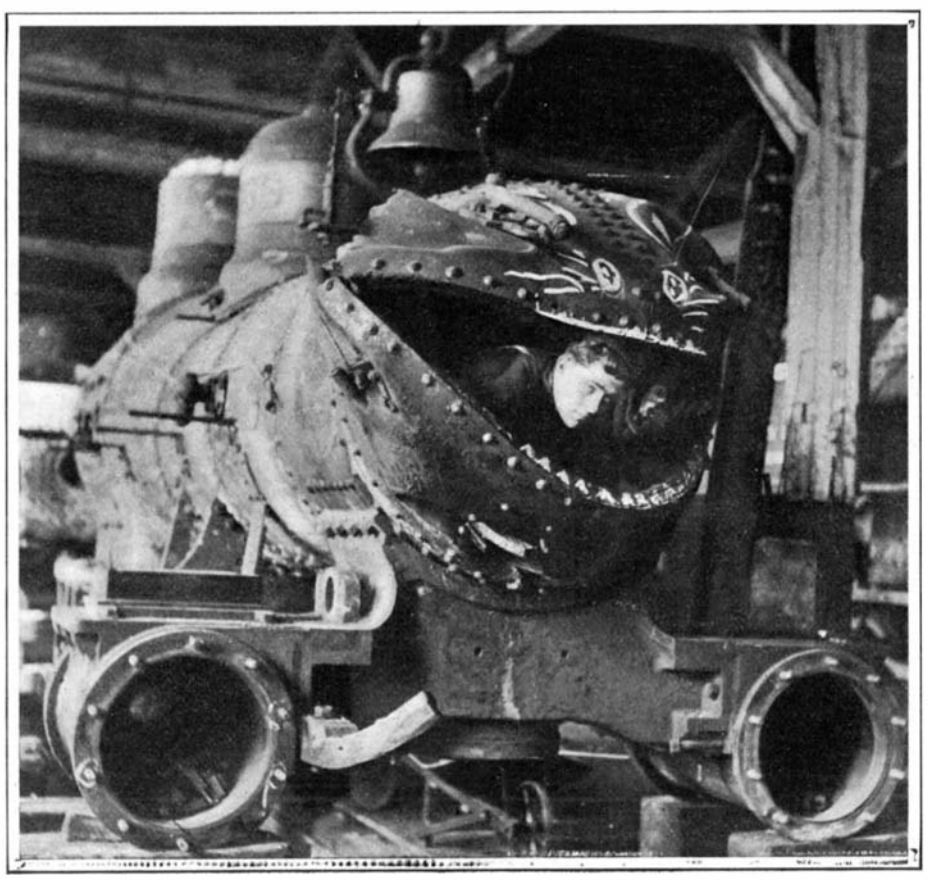
A VERY RARE BRONZE CASTING.

authorities. To make certain the genuineness of the door, Mr. Rudgear had it examined and passed upon by Prof. Italo Mario Palmarini, government inspector of the Royal Galleries of Florence. Prof. Palmarini pronounced it a magnificent specimen of the bronze art of the fifteenth or sixteenth century.

Forest Fires Over Former Battlefields.

Forest fires are under ordinary circumstances sufficiently dangerous to any one so unlucky as to be caught within their circuit, but the following statement proves that there are certain localities where they may be attended with unsuspected peril. Some days ago, says an exchange, the woods in the mountains known as Loudon Heights, opposite Harper's Ferry, took fire and burned with great intensity. After burning for some time a series of explosions were heard, which startled the inhabitants, and the concussion was so great that it broke windows in some houses in Harper's Ferry, across the Shenandoah. The explosions were caused by the bursting of shells, which were thrown on the heights at the time when General Mills surrendered to Stonewall Jackson in 1862. These had failed to explode when they were fired, and had remained there for more than forty years.

Berlin has passed the two million mark in the population of the city proper. On Nov. 27, 1904, according to the police, the register contained the names of 1,998,436 persons, and during the fortnight following, allowing for the ordinary rate of increase, the population had risen to about 2,001,500. The adjoining suburbs have a population of nearly 750,000 persons.



A WRECKED LOCOMOTIVE THAT BEARS AN UNCANNY RESEMBLANCE TO A DRAGON.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

APPARATUS FOR CLOSING ELECTRIC CIRCUITS.—R. DE LAMPRECHT, Paris, France. This invention relates to an apparatus for effecting upon the introduction of one or more coins the closing of an electrical circuit for a predetermined period. It may be used in connection with any apparatus which, through the insertion of one or more pieces of money, is opened for use to the public for a certain time specified in advance—as, for example, self-collecting telephones, auxiliary illuminating devices for railway-trains, etc.—but is particularly suited to effect telephonic communications, for example, by means of the prepayment of specified sum.

ELECTRIC HAMMER.—L. PAULERO, Petersburg, Va. In the present patent this inventor's improvement has reference to electrically-operated hammers, and the more particular object of the invention being to produce a comparatively simple hammer very easily controlled by the operator, and admitting of various degrees of adjustment.

Of Interest to Farmers.

PLOW.—D. G. BURKHART, Dayton, Wash. One purpose of this improvement is to provide details of construction for a plow that adapt it for convenient and effective service as a hillside plow by affording means for quickly changing the moldboard and plowshare from one side of the plow-beam and to the opposite side of the beam, so that by turning the team and the plow around, the plow will operate to turn the furrow over upon the one last plowed and obviating the necessity of plowing around a portion of the inclined land, as is required by an ordinary plow used in hillside-plowing.

STACKER.—P. BROUK, Wilson, Kan. The purpose of the inventor is to so construct the stacker that it may be readily mounted upon and as readily removed from the bed of an ordinary farm-wagon and which can be made very light, yet durable, and built quite high without being cumbersome and also to so construct the stacker that a folding conveyor is employed in connection with an elevator, and especially to provide a horse-power attachment for driving the elevator and conveyor aprons, which attachment can be quickly connected with the framing of the machine or removed therefrom.

SELF-FEEDER FOR THRESHING-MACHINES.—J. JIRSA, Dorchester, Neb. The inventor provides a feeder so constructed that when a surplus of straw is fed to the band-cutters by the bundle-carrier the cutters will continue to act upon the bundles, but the motion of the carriers will be automatically stopped until the normal amount of straw is at the entrance to the machine and in position to be delivered to the concave and cylinder, at which time the driving mechanism for the carrier will again and automatically act to set the carrier in motion, and prevent clogging and ineffective work where the carrier connects with the body of the machine.

FARM-GATE.—J. J. HINER, Woodstock, Ill. The object of the invention is to provide novel fixtures for a gate which are simple, practical, durable, convenient to operate, and inexpensive, which enable the easy opening and closing movement of the gate, permit it to be closed and supported at different heights from the ground, and afford automatic means for locking the gate closed at different heights in a way to resist the efforts of live stock to open it.

APPARATUS FOR DIPPING ANIMALS.—E. W. BENNETT, Rawlins, Wyoming, deceased; D. CLARK, administrator. In carrying out this improvement the inventor had in view as an object the construction of an apparatus through the medium of which animals may be quickly and easily immersed in the bath, and with perfect safety, as the method commonly employed by cattle-owners of forcing animals to jump into the solution, at the risk of broken bones and other injury, is obviated. Means are provided for keeping the cleansing solution at a certain temperature.

GATE.—P. C. FORRESTER, Streator, Ill. In this case the invention relates to improvements in swinging gates for driveways, and of the type designed to be opened and closed from either side by a person in a vehicle, the object being to provide a simple and positive mechanism for causing the swinging movements without binding or straining.

Of General Interest.

BUILDING-BLOCK.—E. E. BENNER, Sargent, Neb. It is the object of this invention to provide an improved building-block adapted to form a wall which shall be strong, durable, firm, and provided with cavities or chambers constituting vertical air passages whereby the radiation of heat is prevented, fire and frost resisted, and material saved.

HOOK AND EYE.—F. L. PRIEST, Houston, Texas. The object of the inventor is to provide features of construction for a hook and eye that enable rapid and cheap manufacture, adapt these coacting parts to be readily engaged with each other, be closed with a snap by lateral pressure, that will not slacken or have play where they engage each other, cannot become accidentally detached, have resilience between the engaged members that insures their remaining connected, and does not permit a gap between the dress flaps which the members join together.

PUZZLE.—I. C. SCUDDER, Middletown, N. Y. This invention relates to improvements in puzzles, an object being to provide a puzzle consisting of two members so formed as to offer some difficulty to attach them, and another object is to provide a puzzle with an advertising device, thus making it useful as an advertising medium as well as amusing.

PROCESS OF REDUCING ORES.—D. R. ROBERTSON, Leadville, Col. Mr. Robertson's invention pertains to processes for separating the values of ores, placer-dirt, sand, and other materials, it being particularly applicable to those containing gold, silver, and copper. Its objects are to provide a ready method of effectively releasing and recovering the values.

SIPHON.—J. J. POWERS, Centralpark, N. Y. One object of the invention is to provide a self-charging siphon with a novel means for causing a quick action of the valve at the outlet end. Another, is to provide at the inlet end of the siphon a simple means for causing a rotary motion of the liquid while passing through the siphon, thus by centrifugal force causing the liquid to impinge closely against the interior of the siphon at all parts, and effectually preventing the entrance of air when the device is in operation, permitting a constant and rapid flow.

BOTTLE.—R. J. MODESPACHER, Hoboken, N. J. The object of the improvement is to provide a bottle more especially designed for containing beer, lemonade, and like beverages, and arranged to allow repeated filling and cleansing the bottle by the bottler, and to permit opening of the bottle by the consumer for pouring the contents and to render it rather difficult, and hence unprofitable, for the consumer to reuse and refill with same or other liquids.

PENCIL.—J. MAKANT, North Adams, Mass. In use when bringing the lead beyond the point or to lengthen it the collar is moved inwardly, releasing the lead from engagement with the sections, the operating member being moved toward the point to protect the lead the requisite amount. Not in use the lead may be released in same manner, and upon moving the operating member in opposite direction the lead may be allowed to fall between sections, where it will not break or soil objects. The eraser is used in the usual way, the sleeve performing double function of holding parts together and serving as protector.

SEWING-AWL.—M. R. BOTKIN, Denver, Col. This invention relates to awls of that character covered by a former patent granted to Mr. Botkin. The structure is simple. Threading of the needle can be accomplished easier than in the prior patent, as the thread is passed through a thread-passage between the jaws before insertion of needle. The spool, while securely fastened in place can be readily detached by unfastening the projections and withdrawing the pin. The jaws have a particular construction. The annular shoulder limits inward movement of the needle, so that it will always be properly positioned. As jaws are cut only to the circular jaw-head there are no notches or slots in which thread can be readily caught.

DISPLAY CABINET OR STAND.—F. R. CURRIE, Mason City, Iowa. The inventor employs a cabinet or stand of special construction at both the front and sides thereof for the reception and storage of tools or other articles, the front being closed by suitable doors, while the sides are closed by doors of special construction to enable the ready display of samples of goods kept in stock or on sale. The structure may be made of any material and of any shape or size to suit the particular location in a store.

PROCESS OF MANUFACTURING BRICKS FROM REFUSE FROM COAL OR COKE.—J. HAMMERSCHLAG, Krutenau 7, Strassburg; H. S. GERDES, JR., Dobben 42, Bremen, and O. DROSTE, Bremen, Germany. In the present patent the invention comprises a process for manufacturing coal bricks, which consists in mixing coal or cokes smalls with peat and solutions of alkalies, or of ammonia, drying the mass if necessary, and pressing the same in a suitable manner.

SUBWAY STRUCTURE.—J. SIMPSON, Veedersburg, Ind. Mr. Simpson's invention has reference to such structures as culverts and the like. Its principal objects are to provide organization of this character which will be strong and may be readily erected. The various elements of his subway structure are preferably molded in concrete, being ready to assemble at the time the ground is broken for erection, this greatly facilitating progress, which is of much importance in connection with work upon railroads and highways.

FURNACE.—E. S. CHASE, Salt Lake City, Utah. The object of the invention is to provide a furnace for steam-boilers and the like arranged to insure complete combustion of the burning fuel, to prevent the formation of smoke, and to utilize the burning fuel to the fullest advantage, and to keep either one or two fireboxes in action under the steam-boiler.

TRANSOM-OPERATOR.—W. ECKSTEIN, London, England. The invention relates to mechanism for operating such closures as transoms, and has for its principal objects the provision of a simple apparatus, smooth and noiseless in action. A form of groove accomplishes the movement with comparative quickness. If desired the resistance may be reduced by decreasing the pitch of the groove. If the operating member displays any tendency to slip upon the pulley, this may be overcome by substituting for a cord a chain, coacting with a toothed wheel.

Machines and Mechanical Devices.

MACHINE FOR CUTTING BUTTER.—C. F. HELFLINGER, Elizabeth, N. J. One purpose in this case is to provide a compact machine so constructed that butter in bulk may be placed in the machine and fed up to vertically-disposed knives, which separate the upper portion of the body of butter into divisions and to provide horizontally-operating knives which, when the upper portion of the body of butter is vertically divided, act to horizontally sever the butter in bulk, thus dividing the upper portion of the bulk into a given number of pats.

BUTTER-CUTTING MACHINE.—C. F. HELFLINGER, Grand Rapids, Wis. The purpose of the improvement is to provide a machine for cutting pats of butter from bulk, which machine is not only of simple and durable construction, but can be conveniently and expeditiously operated to continuously feed a mass of butter to a predetermined outlet and cut from the mass that portion of the butter which is pressed through the outlet.

ATTACHMENT FOR SPINNING-MULES.—J. BOND and L. H. BOND, Waterloo, N. Y. In this case the invention relates to spinning; and its object is the provision of a new and improved attachment for spinning-mules to securely lock the carriage in position when stopped to prevent rebound of the carriage and imperfect formation of the yarn.

PRINTING-COUPLE APPLIANCE.—F. E. KEMPF, Boston, Mass. The object of the invention is to provide a printing-couple appliance arranged to permit quick adjusting of the printing-cylinder relative to the inking apparatus and the impression-cylinder to enable the printer to conveniently and easily "make ready," and insure perfect impressions. This is a division of the application for Letters Patent of the United States for a multicolor-printing press formerly granted to Mr. Kempf.

WEIGHING-MACHINE.—A. G. WITEK, New York, N. Y. The invention pertains to spring-balance weighing-machines, and has for its object to provide an accurate method of ascertaining the weight of human beings or other bodies, objects, and substances of various kinds. A further object is to provide a device that may be used as an article of furniture—such, as a chair or table—without detracting or departing from the general character of such articles.

TYPE-WRITER PLATEN.—C. H. STUART, Newark, N. Y. The objects of this improvement are to provide a platen or roll which shall permit the type to strike the surface thereof at different points, and thereby increase the durability of the platen. Ordinarily in typewriters periods and other characters strike continuously on the same series of points on the platen and gradually form depressions in the surface of great depth, which necessitates frequent renewal of the platen, and keeps it constantly in a roughened condition.

DOUBLE ROTARY FORCE-PUMP.—J. R. NORTON, San Antonio, Texas. The aim of this inventor is to provide a new and improved double rotary force-pump which is simple and durable in construction, not liable to get out of order, very effective in operation, and arranged to render the pump positive in its action, and to prevent any loss of power. The stream sucked up and forced out by the action of the pump is continuous.

PRINTING-PRESS CYLINDER.—G. K. HENDERSON, New York, N. Y. The object of this improvement is to provide a cylinder for printing which will not have certain undesirable features, but will have the advantage of employing a speedy and economical system of using thin, flat, flexible plates of zinc or aluminium at present in use for lithographic or printing purposes, and having novel means for bringing the whole into exact register.

APPARATUS FOR COOLING LIQUIDS.—C. GROHMAN, Carteret, N. J. In the present patent the invention relates to apparatus for cooling water used for cooling purposes in condensers and other machines. The object of the invention is the provision of a new and improved apparatus for cooling a liquid in a very simple and inexpensive manner, and mainly by the use of atmospheric air.

LEATHER-POLISHING MACHINE.—W. H. GERRITY, New York, N. Y. The apparatus comprises a framing having two endless chains running on sprockets arranged in vertical planes, the chains carrying the skin-sustaining boards, so that by this means the hides are moved through the machine, the hides being manually placed on and removed from the boards. On the framing are arranged one or more pairs of polishing-rollers. These rollers are arranged to have the skin-carrying boards passed between them, and are driven revolubly, so that as the boards carrying the skins pass between the rollers the rollers act on the skins to attain the result.

CALCULATOR.—R. N. COOPER, Saybrook, Ill. This invention pertains to registers, and more particularly to slide-rules; and its object is to provide a new calculator designed for obtaining mathematical computations, such as multiplication and division, raising a number to a given power, extracting roots, finding the natural sine or tangent of an angle, and also the logarithm of a given number.

FRUIT-PRESS.—H. BOLLWEBER, Spokane, Wash. In this case the invention refers to improvements in machines for pressing juice from fruit or fruit-pulp, the object being to provide a press of simple and inexpensive construction, anl by means of which the juice may be rapidly and uniformly pressed out.

Prime Movers and Their Accessories.

BOILER-FEEDER.—C. E. FINCH, Forney, Texas. In the present patent the invention is in the nature of a novel feeder for supplying steam-boilers with water in an automatic manner by gravity, so as to maintain the water in the boiler at a practically uniform level. The feeder works equally well with any chamber having an inlet check-valve.

TOOL FOR OPERATING UPON BOILER-TUBES.—J. L. SMITH, Eureka Springs, Ark. Mr. Smith's invention relates to tools for use in removing tubes from the flue-sheets of boilers and in applying new tubes. With this combination-tool the whole operation of cutting out the old tube and inserting the new may be performed, and the elements which carry out the various operations may be quickly assembled, and will operate under application of comparatively low power.

PNEUMATIC ACTUATING DEVICE FOR THE REVERSING-GEARS OF LOCOMOTIVES.—F. WARTHER, Canal Dover, Ohio. In carrying out the present invention the inventor has in view as an object the provision of a new and improved pneumatic actuating device for the reversing-gear of a locomotive arranged to permit the engineer to quickly reverse the engine whenever desired without exerting much physical force.

SLIDE-VALVE MECHANISM FOR STEAM-ENGINES.—F. E. SMITH, Munnsville, N. Y. Locomotives now in general use are so designed that when the stroke of the inlet-valve is reduced to lessen the amount of steam admitted upon each stroke there is a similar reduction of the stroke of the exhaust-valve, and for any reduction of the amount of steam admitted to the cylinder there is a corresponding reduction of the exhaust. This is exceedingly undesirable, because the steam in front of the piston opposes a considerable resistance to the movement of the latter. In the present invention this objection is overcome by providing a separate inlet-valve and exhaust-valve for each engine-cylinder, independent mechanism, preferably comprising link-motion devices for reciprocating said valves, and mechanism for reversing the stroke of both valves simultaneously, which permits the reduction of the stroke of the inlet-valve without affecting in any way the stroke of the exhaust-valve.

Railways and Their Accessories.

RAILROAD-FROG.—P. KYLE and J. R. CRESS, Coalbluff, Ind. An object of this invention is to provide a frog for railroad-switches which shall have its movable part locked when in use against any tendency to be moved or tilted by the lateral outward force of the car-wheel flanges when passing over the same. Means are provided by which the movable part of the frog shall also be automatically clamped to the fixed part thereof by said lateral outward pressure of the wheel-flanges in proportion to force of said pressure.

SELF-OILING CAR-WHEEL.—E. T. THAYER, Charleston, W. Va. The object of this improvement is to provide in a car-wheel of the same general type as that for which Letters Patent were formerly granted to Mr. Thayer, a novel removable closure-cap at the outer end of the wheel-hub to facilitate the cleaning of the oil-chamber within the hub and to provide for the introduction of oil within the chamber with less difficulty than in the wheel in the above-mentioned patent.

AIR-BRAKE.—H. MINNICK, Laredo, Texas. This is an attachment to be applied to the usual automatic air-brake system having communication with the train-line auxiliary reservoir and triple exhaust, and by means of which the pressure may be held in the brake-cylinder, keeping the brakes applied while the train-line pressure is raised and the auxiliary reservoir recharged, after which the brake-cylinder pressure may be released at will, permitting all the parts of the apparatus to resume normal running and released position.

Pertaining to Vehicles.

TIRE-PROTECTOR.—N. CAMPBELL, Elizabethtown, Ohio. The invention refers to protective devices or armor for rubber tires, pneumatic, solid or partially solid, or such yielding or elastic tires as are used upon automobiles and other road-vehicles. The purpose is to provide a readily-applied device constructed in sections, one having limited movement over the other, which device when applied to a tire will completely cover and protect it from puncture and direct wear without in any manner detracting from the elastic qualities of the tire.

Designs.

DESIGN FOR A BACK FOR HAND-MIRRORS, BRUSHES, OR SIMILAR ARTICLES.

–M. T. Goldsmith, New York, N. Y. This is an ornamental design for a back for hand-mirrors, brushes or similar articles. The mirror portion is circular with a graceful handle. A beautiful figure of a lightly-clad female is extended amid encircling flowers.

Note.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of the paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

MUNN & CO.

Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 6712.—For manufacturers of lead pipe making machinery.

For bridge erecting engines. J. S. Mundy, Newark, N. J.

Inquiry No. 6713.—Wanted, address of parties weaving cotton tubing in 24-inch lengths or longer.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 6714.—Wanted, address of parties making or selling spring motors.

Perforated Metals, Harrington & King Perforating Co., Chicago.

Inquiry No. 6715.—For manufacturers of small chains, like bicycle chains, small enough to take place of tape which operates typewriter carriages.

Handle & Spoke Mchy. Ober Mfg. Co., 10 Bell St., Chagrin Falls, O.

Inquiry No. 6716.—For parties having good rubber reclaiming process.

Commercially pure nickel tube, manufactured by The Standard Welding Co., Cleveland, O.

Inquiry No. 6717.—Wanted, address of violin maker's tools.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co., Box 13, Montpelier, Vt.

Inquiry No. 6718.—For firms in United States manufacturing apparatus for the dry distillation of wood, for producing alcohol, charcoal and other products.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company, Foot of East 138th Street, New York.

Inquiry No. 6719.—For manufacturers of machines making shipping tags.

Gut strings for Lawn Tennis, Musical Instruments, and other purposes made by P. F. Turner, 46th Street and Packers Avenue, Chicago, Ill.

Inquiry No. 6720.—Wanted, address of manufacturer or dealer in water glass.

In buying or selling patents money may be saved and time gained by writing Chas. A. Scott, 719 Mutual Life Building, Buffalo, New York.

Inquiry No. 6721.—Wanted, address of firms manufacturing or selling devices for printing quotations, etc., on postal cards with metal or rubber type.

We Manufacture on Contract anything in light Hardware. Write us for estimates. Edmonds-Metzel Mfg. Co., 143-153 South Jefferson Street, Chicago.

Inquiry No. 6722.—Wanted, address of manufacturer of railway ticket machines.

We manufacture iron and steel forgings, from twenty pounds to twenty-five tons. Crank shafts of all varieties. Erie Forge Company, Erie, Pa.

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Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, machinery and tools. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

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Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.

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Minerals sent for examination should be distinctly marked or labeled.

(9605) C. J. J. Co. says: Can you do us the favor to answer in the columns of your paper the following question? We desire to know how much water will be lifted by a simple undershot wheel having straight paddles, 14 in number, symmetrically spaced around the wheel. The wheel is 14 feet in diameter with paddles 6 feet long and 16 inches wide. The wheel revolves eight revolutions per minute and dips into the canal carrying water 16 inches deep, the ends and edges of the paddles fitting the canal quite closely, not more than ¼-inch slack showing at any point. The canal is curved to compel the wheel to lift the water 2½ feet so that the total duty is a lift of 2½ feet for the width of the wheel. Can you give us an opinion as to the amount of water that would be lifted by such an apparatus, and the power required to operate it? A. If we understand your question aright, the wheel is to be driven by external means, and used in a sense as a pump to lift the water in the canal up a curved incline two and a half feet. If this assumption is correct, and if there is no slip between the water and the paddle wheel and no leakage past the paddles, 2,500 feet of water will be lifted per minute, which would require, if the efficiency of the apparatus were perfect, 12½ horse-power. As a matter of fact, however, there will be a certain amount of leakage past the paddles, amounting to 10 per cent, or possibly 20 per cent. This would decrease the quantity of water actually lifted from 2,500 to 2,250 cubic feet, and as the efficiency of the apparatus is not perfect, it will require more power by a considerable amount. The efficiency of this device would probably not be far from 55 or 60 per cent. This would increase the power actually required to drive the wheel to from 16 to 20 horse-power. In order to have a reasonable margin of safety, it would be well to allow 25 horse-power. If this device is to be used, it will be necessary to either use buckets in place of flat paddles in the paddle wheel, or else to have paddles considerably wider than 16 inches, or else to have them made with a piece at right angles at the top of the paddle to prevent the water from running back over the top of the paddle after it has been lifted a portion of the way up the incline.

(9606) E. S. asks: Will you kindly give me the scientific reason for the hour before dawn being the darkest and coldest, particularly the former? A. We do not know any scientific reason for the belief among people that the hour before dawn is the coldest and darkest. The popular proverb is, "It is always darkest just before dawn," which we always understood to refer to the mental attitude of a man who is hard pressed and finds help. The coldest hour of the night is found to be from 3 to 4 A. M. The darkest hour is when the sun is furthest below the horizon, or midnight. We do not see any other scientific conclusion. All daylight is gone from the atmosphere after the sun is 18 deg. vertically below the horizon, the time which marks the end of twilight of evening and the beginning of the morning twilight. Between these two times it is deep night and there is no reason why one of the hours should be darker than another.

(9607) W. A. P. asks: I am building a 12-inch spark coil according to Allsop directions. What test can I make to find if I have a good or perfect condenser? If I put 250 volts 1 lamp in series across the foil ends I get no trace of leakage or short circuit, but 110 alternating lamp series does not light the lamp, but there is a big leakage—so much that it cannot be held in the hand. I refer to using the condenser only, as the coil has not yet been built. I have 20 sections secondary built on the primary and receive only ⅜-inch spark with or without condenser, the maximum number being 96 sections. Does this appear right? A. The leakage of a condenser is found by charging it and discharging it immediately, then charging it and leaving it for say 15 minutes and discharging it again. The ratio of the discharge gives the leakage. There is no way of finding the leakage without proper instruments to measure with. We do not see any proof of leakage in what you write, though what you say is not clear. If you mean that a direct current of 220 volts shows no leakage, while with an alternating current 110 volts gives effects across the condenser, we reply that an alternating current does not charge a condenser at all. A condenser is not used on a coil when the alternating current is used with it. Without instruments or means of measuring the condenser you should make sure of each sheet of the paper, make the condenser as well as possible and rely upon the thoroughness of your work.

(9608) A. B. asks: Two weeks ago I purchased from you Hopkins's "Experimental Science." In the description of the ¼-horse-power motor in Volume I., I find a few dimensions missing: 1. Diameter of poles of fields. 2. Width of coils on poles and number of layers of wire on same. 3. When soldering wires to bars of armature, should both ends of twisted wires (when cut apart) be connected to same bar? If not, how should they be connected? 4. What thickness of leather board should be used for the lining of armature grooves? 5. Must there be an insulation between armature disks and sleeve? 6. Total thickness of disk (not counting flange and nut of sleeve). 7. In Fig. 498 on page 514, should first coil go from 18-1 to 9-8 as shown, or from 18-1 to 10-9? 8. What size wire should be used for spring of carbon brush? 9. Diameter of driving pulley. 10. Should field magnet be of wrought iron, or would cast iron answer the purpose? 11. Is it necessary that there be insulation between each layer of wire in armature and also in field? 12. Would you please give me data for the construction of the rheostat—wire, etc.? A. The dimensions of the parts of the motor described in "Experimental Science," Volume I., page 510, which are not given in the list of sizes, may be determined by measuring drawings in which the parts appear with others whose dimensions are given. Thus in Fig. 497*a*, the diameter of the pole pieces can be found from the diameter of the field-magnet drum. You will find them to be 2¼ inches. From the same figure the thickness of the field coils is determined to be 1 inch. We do not know the number of layers of wire in each field coil, but you must wind 1⅞ pounds in each coil. The number of layers will be determined by your skill in winding the wire closely. In soldering the wires to the bars of the armature, solder the end of one coil and the beginning of the next to the same bar. Any thickness of leather board may be used which will not be cut by the wire in winding. A piece of the thickness of heavy paper should be sufficient. No insulation is required between the armature disks and the sleeve. It would have been specified had it been required. We do not know the number of armature disks which will be required to fill the space allotted to them on the sleeve. No. 25, B. & S. gage, is 0.0179 inch thick. Slight inequalities and roughnesses will probably prevent you from bringing the disks into actual contact all over their surfaces and so you will not get the total number into the core which this thickness would indicate. The coils of the armature are to be put into the slots as given in the winding plan. Follow the directions closely. For a spring upon the carbon brushes several sizes of wire would do equally well. No. 16 or 18 will answer. The driving pulley should be of a size to produce the proper speed in the machine to be driven by the motor, which is to give 1,600 turns per minute. From this you can calculate the diameter of the pulley required. The field-magnet frame is of cast iron. The cut shows the mark where the two parts of the pattern came together in molding for the casting, in Fig. 497. The insulation between the layers of wire in all the coils is thick shellac, which is dried by baking the coils after they are wound. We have no data for the rheostat. Usually a rheostat giving three speeds is purchased. One with the coils imbedded is to be preferred.

(9609) G. C. T. asks: Will you kindly answer through the notes and queries column the following questions? 1. While trying to find the direction of magnetic lines of force in the fields of a small dynamo I used a hand compass, and after letting the compass touch the poles a few times I found that the north end of the needle had been influenced some way and would be at rest only when pointing due south. The compass is still in that condition. Please explain reasons for this and a way to change needle back to original condition. Compass is inclosed in brass case and with what I suppose is a steel dial. A. The needle of your compass has its magnetism reversed by the dynamo field in some way, so that the former north end is now south. To restore it to its former polarity, place the compass so that the needle cannot turn and bring the end which you wish to have north against the south or minus pole of the dynamo. In a short time the needle will be charged in the proper direction. 2. Is it necessary with a series-wound dynamo to have the external circuit closed when starting, provided the field coils are separately excited? A. It is necessary to have the external circuit of a series dynamo closed when it is started. It will not generate E. M. F. on open circuit, since no current can flow around the field until the external circuit is closed. It is not the same with a shunt machine, which has its field circuit always closed. 3. Are series or shunt wound field coils best adapted for dynamos that are direct connected, or does the manner of winding affect the coupling of dynamos in any way? Hawkins's "Catechism of Electricity," page 157, states that dynamos of the under type are invariably used for direct connections but does not say whether manner of winding affects this or not. A. Series-wound dynamos are not used in parallel or coupled together, because if either generates too little current that fact reduces its power to generate still further and finally reverses the machine, which short-circuits the system. These matters are fully discussed in Crocker's "Electric Lighting," two volumes, which we can send for $6.

(9610) A. L. R. asks: 1. In running levels for a waterway of considerable length, like the Panama Canal, is not the rotundity of the earth an important factor that must be considered? A. In running levels for waterways of considerable length the line which is actually run is substantially a circle whose center is the center of the earth. The sites taken by the instrument between successive settings are so short that the curvature of the earth does not appreciably affect them, and at each new setting of the instrument the line of the level is parallel to the circumference of the earth at that point. 2. If it were possible to stretch a wire, perfectly taut, across a lake ten miles in width, so that it is perfectly level and absolutely without sag, would it not be necessary that the shore end of the wire be anchored at an elevation of not less than 16 2-3 feet above the water to prevent the immersion of the wire at the center of the lake? A. If it were possible to pass a perfectly straight line across a lake ten miles in width, the anchors must be elevated not less than 16 2-3 feet above the water to prevent the line from going below the level of the water at the center. 3. An extensive and perfectly level plain is traversed by a range of mountains; to pierce which, for a railroad, requires a tunnel ten miles in length. If such a tunnel is excavated with a floor perfectly level, as indicated by the surveyors' level or by "tees" placed at both ends and the center, assuming the possibility of sighting that distance, would not the center of the tunnel be lower than either end or than the plain outside, and would not the water in the tunnel drain toward the center? Would the specific gravity of an object placed in the center of the tunnel be affected by the superincumbent weight of the mountain mass? A. If the tunnel which you mention were to pierce a range of mountains ten miles long, it would not go in a straight line with the mountain, but be an arc of a circle whose center was the center of the earth, or else, as a matter of good engineering practice, it would be enough higher in the center, than indicated in the above statement, to allow drainage in both directions. If such a tunnel were excavated with a surveyor's level stationed at the point where the range of mountains left the level plain on one side, it would come out on the other side of the mountain range 65 feet above the plain. If the tunnel were excavated in an exact straight line from the plain on one side to the plain on the other, at the entrance of the tunnel on either side there would be a down grade of 65 feet in ten miles, or 6½ feet to the mile. The tunnel would be level in the center, and would be at that point 16 2-3 feet below the surface of the plain. The specific gravity of an object placed at the center of the tunnel would be slightly less than outside on the plain, because of the influence of the mountain.

(9611) H. M. says: Please give the best receipt for making whitewash for outside work. A. A good durable whitewash is made as follows: Take ½ bushel of freshly burnt lime, slake it with boiling water; cover it during the process, to keep in the steam. Strain the liquid through a fine sieve, and add to it 7 pounds of salt previously well dissolved in warm water; 3 pounds of ground rice boiled to a thin paste and stirred in boiling hot; ½ pound powdered Spanish whiting; 1 pound clean glue, which has been previously dissolved by soaking it well, and then hanging it over a slow fire in a small kettle, within a large one filled with water. Add 5 gallons of hot water to the mixture, stir it well, and let it stand a few days covered from dirt. It must be put on quite hot. For this purpose it can be kept in a kettle on a portable furnace. About 1 pint of this mixture will cover a square yard.

(9612) C. F. writes: Some time ago I read about a liquid or composition which placed into a tree stump or roots would rot and thereby destroy them. Could you explain this or any other similar process of destroying tree stumps? A. In the fall bore a hole in the center of the stump, about 18 inches deep and 1 to 1½ inches in diameter. Put in about 2 ounces saltpeter, and fill the hole with water; plug it up tight. In the spring take out the plug, pour in 8 or 10 ounces petroleum, ignite, and the stump will smolder, but not blaze, to the extremities of the roots, leaving only ashes. Dynamite is also extensively used.

(9613) W. B. asks: 1. A chicken gains about twice in weight for the first twenty-four hours after hatching. What do they live on, as they do not eat anything? A. It is true that chicks can go for several days without food, as there is sufficient of the egg left in the stomach to supply nutriment. They will eat on the first day, however, if food is provided. Chicks almost double in size the first day, owing to the organs being relieved from

the compression of the eggshell, and as the down on the chick dries, it fluffs out and adds to the apparent size. It may be that in individual instances they double in weight, but it is far from true as a general rule. We have known cases where the reverse was true. Where too much moisture has been kept in the incubator, the egg does not dry down enough, and the chicks hatch in a swollen, puffy condition. During the first day the surplus water in them evaporates, so that they shrink, and weigh less than when they were hatched. It may be true, too, that when there has been too little moisture in the incubator, and the eggs have been dried down too much, the chick will absorb moisture after being hatched and so increase in weight. Where the chick has been hatched under a hen, or where the conditions of moisture have been kept just right in the incubator, there will be very little, if any, change in weight during the first day. 2. A hard-boiled egg weighs quite a bit more than a raw egg. Where does it get the extra weight? A. The shell of an egg is very porous, and moisture and air also pass through it without difficulty. Hence in boiling water is absorbed by the egg, and this increases the weight of the egg. 3. Why does sap run up the tree? A. Sap is carried up a tree by osmotic pressure and capillarity, chiefly. The evaporation from the leaves tends to assist the flow during the season when the leaves are on the trees. These matters are explained in textbooks of physics.

(9614) R. A. asks: Would you please explain to me if a magnetic needle would show any greater resistance to turning out of directions if it was made much longer, if it had a large surface, of if it was made with electro-magnets. A. A long magnetic needle swings more slowly than a short one, and one with a larger surface in a vertical direction is resisted by the air more than a flat needle. It makes no difference to the swing whether the needle is a permanent or an electro-magnet.

(9615) M. S. asks: Is it not the tendency of a bullet fired from a rifle to ascend until it has spent its force? A. A bullet is a falling body, and descends by gravity after it leaves the gun, just as if it were dropped through the air. For this reason a bullet will not hit a target if the gun is aimed directly at the target. The sights of the rifle are so adjusted as to point the gun above the target to such an extent that the bullet will curve up above the target and down to the target when it has flown for the time required for the bullet to pass from the gun to the target. This curving increases as the distance from gun to target increases. A ball from a gun fired in a level line does not curve upward or ascend till it has spent its force. If it were so, there could be no science of gunnery.

(9616) H. H. A. asks: Kindly answer the following question: Does the date change between points on opposite sides of the 180 deg. meridian, or is it merely nautical reckoning that recognizes the date line? A. The date changes at any place when the line or meridian of midnight passes over that place. The date is constantly changing all the way around the earth during the twenty-four hours of any day. The international date line is a line which is very nearly coincident with the 180th meridian. To the east of that line the date is always one day later than on the west of that line. Night covers half of the world all the time. The meridian through the middle of the night is moving all the time around the earth. On the east of that meridian there is one day, on the west of that meridian there is another. A day is dying on the west side of that meridian, a new day is coming on the east. At eleven at night in your place, the line of midnight is one hour to the east of you. The day has one hour left. The next day is only one hour away to the east. In an hour it has reached you and passes over your head, speeding west ceaselessly, around and around the earth. However, when a ship passes the 180th meridian, it changes its date, since it has passed out of one day into another.

(9617) E. A. W. asks: 1. Why does a condenser increase the current in an induction coil, and is one necessary in wireless telegraphy? A. The condenser suppresses the spark which would be produced on the closing of the primary circuit of an induction coil and intensifies the spark upon the breaking of the primary circuit. All coils which are to throw sparks must have condensers. Hence one must be used in wireless telegraphy. The full action of the condenser is given in answer to Query 8184, Vol. 84, No. 20, which we send for ten cents. 2. Could a spark coil such as are used on gasoline engines be used instead of an induction coil? A. If the spark coil of the gasoline engine has a primary and a secondary winding and condenser, it may be used to send wireless signals for a short distance. 3. How large a coil and how many batteries would be needed in a wireless outfit between two places 500 feet apart? A. We should not advise any one to experiment with wireless telegraphy over any short distance even without having a coil capable of giving an inch spark. 4. Which is best in a wireless telegraph receiver—a coherer containing carbon granules connected directly with the battery and a telephone receiver, or a coherer containing nickel or brass filings with a decoherer and connected with a relay which operates a sounder? A. The coherer should contain metallic filings, and be provided with a tapper to decohere the filings. 5. Does there have to be a spark in the secondary coil to make the Hertzian waves? A. The Hertzian waves are produced by the surgings of the discharges of an induction coil, or some other electric discharge of similar character. Lightning produces them. 6. Can a magneto generator be used in a transmitter? A. A magneto cannot be used as a transmitter unless it can be used to send current through the primary of the induction coil, and they are not usually wound for any such purpose. 7. What size of wire is usually used in winding electric bells? A. Any size of wire may be used upon an electric bell which will allow current enough to pass to magnetize the core of the magnet and thus ring the bell. To ring through great resistance a fine wire, No. 30 to 36, is commonly employed, and as many as 1,000 ohms may be wound on the spools. 8. If a meteor is heated by friction with the air, how is it heated when it is out in space? A. A meteor is not heated on the outside of the earth's atmosphere. In external space the temperature is supposed to be in the neighborhood of absolute zero, and all small bodies there must be as cold as the place in which they are.

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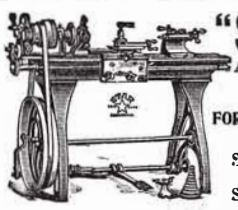

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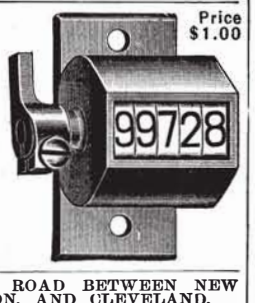

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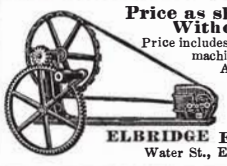

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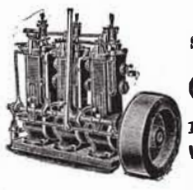

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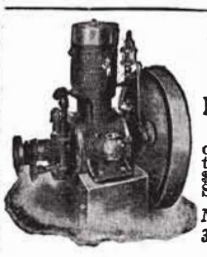

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NEW BOOKS, ETC.

HOW TO KNOW THE STARRY HEAVENS. An Invitation to the Study of Suns and Worlds. By Edward Irving. New York: Frederick A. Stokes Company, 1904. 12mo.; pp. 313. Price, $2.

This book is a popular introduction to the study of astronomy, and in its pages will be found a careful selection of the most typical, interesting, and instructive facts and theories known so far concerning the universe. These are described and illustrated in a way that will make them attractive, not only to the general reader and beginner, but also to persons having a more advanced knowledge of the subject. The idea of the author in writing this book (which is the first of a series dealing with the sciences of astronomy, biology, and sociology) is to give a bird's eye view of the subject without the confusion of too many details. The figures given in the work are mostly in round numbers, and while they may not be absolutely accurate, they are fairly so. Within the twenty-five chapters of the book such subjects are dealt with as the Construction and Dimensions of the Universe and Principles Utilized in Measuring It; Kepler's Three Laws; Galileo's Laws of Motion; Newton's Laws of Gravitation; the Nebular Hypothesis, and many theories and discoveries regarding it, as well as the various Modifications of the Nebular Theory; the Apparent Motions of the Heavenly Bodies, as Shown by Observation, and the Rival Theories to Explain Such Apparent Motions; Some Problems Used in Celestial Measurements; the Principles and Applications of the Spectroscope; Lunar Geology and Geography and Igneous Forces on the Moon and Elsewhere. The book is very completely illustrated with no less than 128 full-page illustrations and 121 smaller cuts, besides a number of colored charts. Many of the half-tones are from excellent photographs of the heavens obtained in the various leading observatories. Altogether, this book forms one of the best popular treatises which has yet come to hand.

PRACTICAL ELECTRIC-LIGHT FITTING. By F. C. Allsop. New York: The Macmillan Company, 1905. 12mo.; pp. 283; 242 illustrations. Price, $1.50.

This work, which is now in the sixth edition, forms a treatise on the wiring and fitting up of buildings deriving current from central station mains, and the laying down of private installations. It is a thoroughly practical treatise for fitters and others who require plain, practical instruction and diagrams, rather than abstruse mathematical formulæ. All forms of switches, cut-outs, lamps, meters, heaters, storage batteries, dynamos, etc., used in electric lighting are described in detail, and full descriptions, illustrated with diagrams, are given regarding the wiring of buildings.

UNCOOKED FOODS AND HOW TO USE THEM. By Mr. and Mrs. Eugene Christian. New York: The Health Culture Company, 1904. 12mo.; pp. 246. Price, $1.

This book is a treatise on how to get the highest form of animal energy from food. It opens with a general consideration of the food question, and the various products, such as cereals, fruits, nuts, milk, etc., are discussed and comparative tables of food values, time of digestion, etc., are given. The effects of cooking upon various kinds of food are set forth in full, the authors claiming that the application of heat in the cooking of food destroys some of the vital and organic food elements by rendering them inorganic. Many of these elements are needed in building up the system and maintaining the bodily and mental health. The book tells how to begin the use of uncooked foods, and discusses their proper use under various conditions. About 200 receipts for the preparation of fruits, cereals, vegetables, nuts, salads, cakes, puddings, sauces, etc., together with a seven days' menu, are given; and these show very clearly how much can be done in the way of setting an attractive table with purely uncooked foods.

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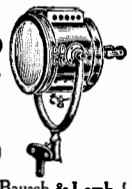

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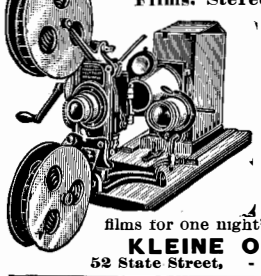

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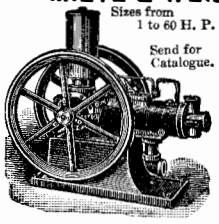

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How to Mix Paints. By C. Godfrey. New York: The Industrial Publication Company, 1904. 12mo.; pp. 64. Price, 50 cents.

This small book gives simple and clear directions for the mixing of paints so as to obtain various shades and tints that may be found desirable for house painting and the like. Besides the above information, there are notes on color harmony, shades, and tints, the use and care of brushes, etc. The book will be found useful by both amateurs and men in the trade.

Jiu-Jitsu. The Wonderful Japanese Method of Attack and Self-Defense. By Captain Harry H. Skinner. New York: The Japan Publishing Company, 1904. 8vo.; pp. 118. Price, $1.

This much-talked-of Japanese method of self-defense without the aid of weapons is here illustrated by sixty-five photographs, which were posed for by B. H. Kuwashima, of Columbia University. Each illustration is described in simple language in such a way that the amateur, by studying the illustrations in connection with the diagram showing the muscles, bones, and arteries of the human body, can soon learn to perform the various tricks described. The fact that the United States government has taken up Jiu-Jitsu, and taught it to the naval and military students at Annapolis and West Point, shows that it is a method of self-defense which can be relied on, and which gives confidence to the person who knows it sufficiently well to be able to use it in emergencies.

Preliminary Report of the Ohio Co-operative Topographic Survey. By C. E. Sherman, Inspector.

This report is printed by the State of Ohio for gratuitous distribution. The survey is being carried on in connection with the United States Geological Survey, and the survey sheets of the different towns may be had from the Director of the latter survey at Washington, D. C., for five cents each. The report gives the legislation that was passed with reference to this survey, and some of the preliminary work that was done.

A Handbook for Superintendents of Construction, Architects, Builders, and Building Inspectors. By H. G. Richey. New York: John Wiley & Sons, 1905. 16mo.; pp. 742; 357 figures. Price, $4.

This book is one of the best pocket handbooks for builders, carpenters, contractors, and superintendents of construction which we have seen. It starts with the building of foundations of various sorts, and follows this with information on stone laying, setting, and cutting; marble and slate work; brickwork, bricklaying, and paving. Concrete construction, fireproof construction, and fire protection of buildings are discussed in Part III. Part IV deals with lathing and plastering; carpentry; plumbing; tin and sheet-metal work; painting, glazing, and paper hanging; iron work, electric wiring, and heating. The laying out of work, mensuration, and drawing are discussed, as are also hydraulics and the strength of various materials. The book is completed by various engineering formulas and tables that always come handy to the engineer. It is thoroughly up-to-date in every particular.

Strength and Elasticity of Structural Members. By R. J. Woods, M.E. New York: Longmans, Green & Co., 1904. 8vo.; pp. 310. Price, $3.65.

This book is a very complete textbook for students of engineering. It is extremely practical in character, and the methods described are simple and concise, and involve only a fair knowledge of elementary mathematics. All kinds of forces, stresses, and the way they affect girders, beams, retaining walls, riveted joints, etc., are thoroughly described, and the mathematics relating to them are given. Not the least useful are the chapters on cantilever and suspension bridges. The book will be found useful by all students in engineering, and also to men engaged in all kinds of engineering work.

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AND EACH BEARING THAT DATE

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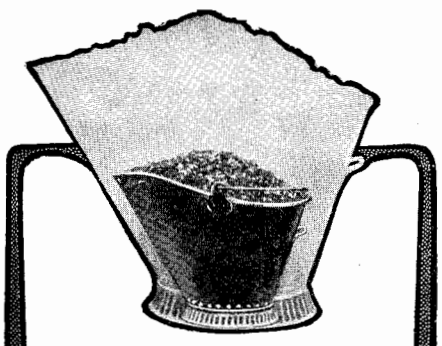

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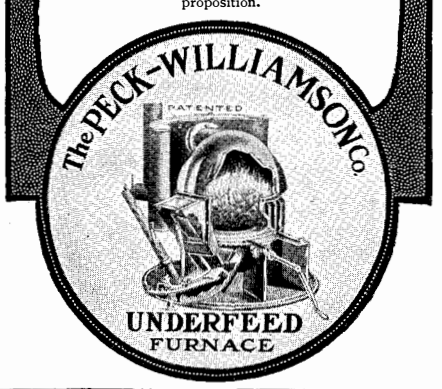

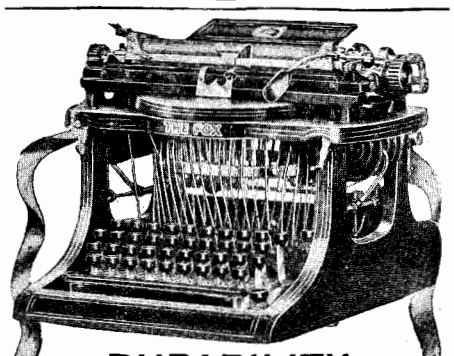

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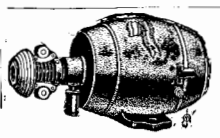

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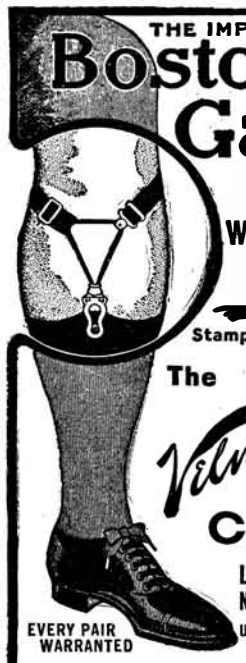

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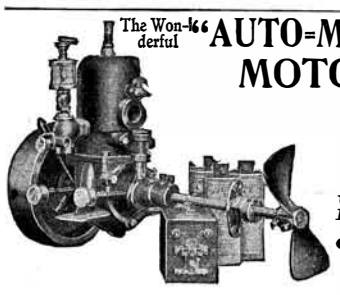

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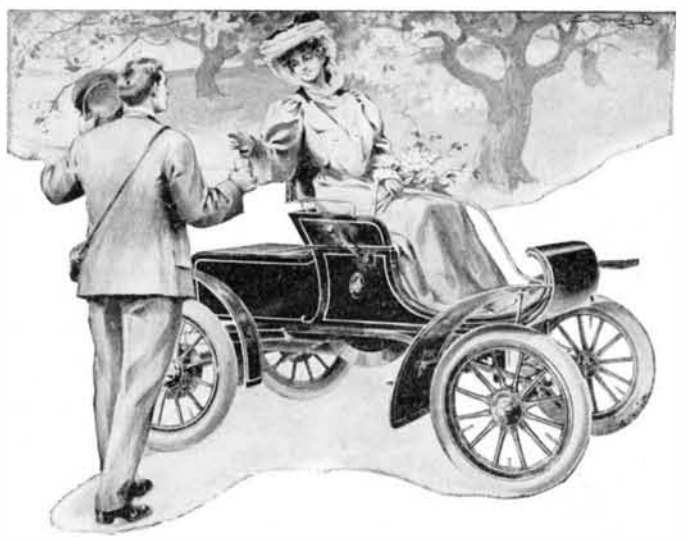

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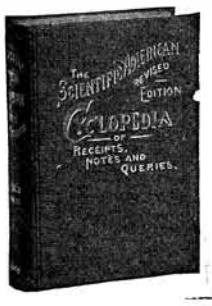

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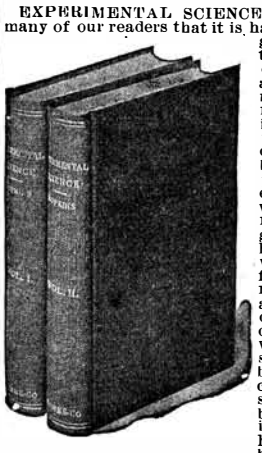

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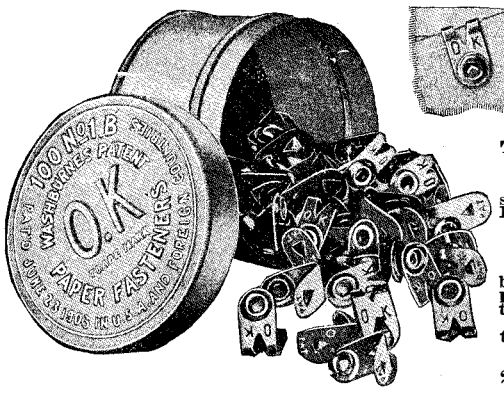

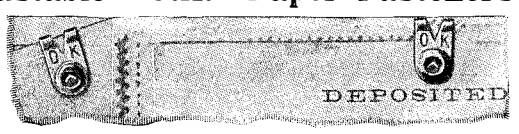

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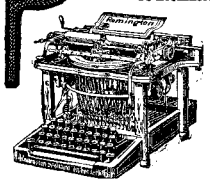

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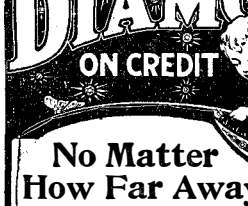

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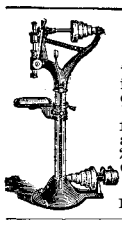

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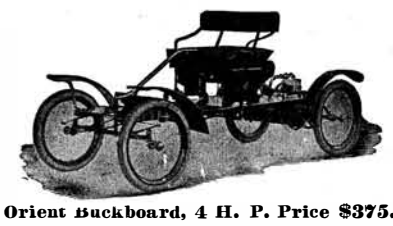

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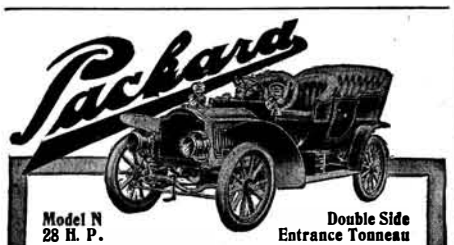

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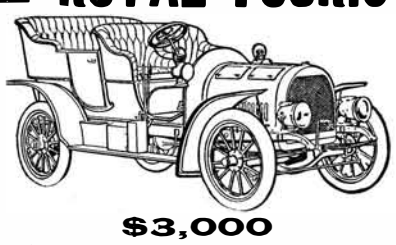

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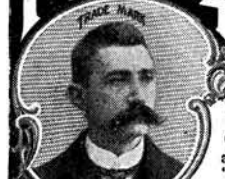

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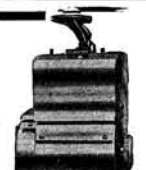

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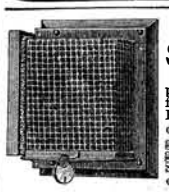

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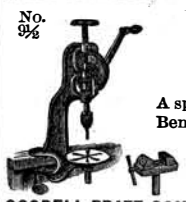

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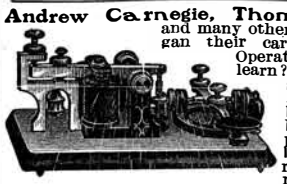

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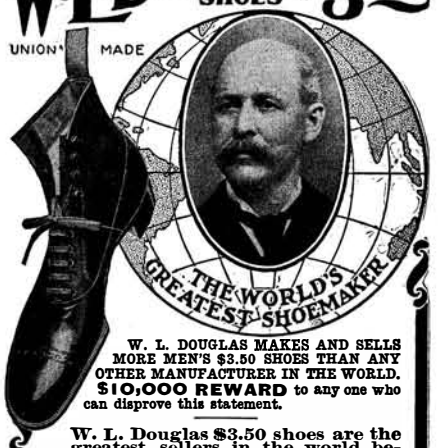

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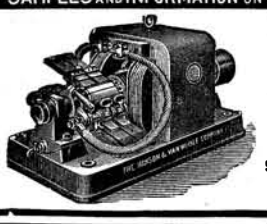

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